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Organized in 1935, the Institute engages in a wide range of activities, and offers many services to farmers and agricultural leaders. These activities and services include: fellowships and research grants in agricultural colleges and experiment stations; fertilizer demonstrations, in cooperation with agricultural extension forces, soil conservation service, county agents, vocational agriculture teachers, and other groups; education in efficient use of potash, through publications, motion pictures, radio, television, books, and advertising. The Institute's monthly magazine, "Better Crops With Plant Food," goes regularly to 24,000 teachers, county agents and other agricultural leaders. Regional newsletters, reprints, and direct service to the farm press also constantly help explain the importance of potash in balanced soil fertility.

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THE AMERICAN POTASH INSTITUTE, INC.

1102 Sixteenth Street, N.W., Washington 6, D. C.

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WRITE DEPT. A AT THE ABOVE ADDRESS

Better Crops with PLANT FOOD

The Whole Truth—Not Selected Truth

SANTFORD MARTIN, JR., *Editor*

Editorial Office: 1102 16th Street, N. W., Washington 6, D. C.

VOLUME XLI FEBRUARY, 1957 NO. 2

ON THE COVER THIS MONTH . . .

. . . Potash teams up with nitrogen and phosphate to make the sugar beet a healthy, sugar-full plant—like the one in the center. The plant on the left, suffering from potash deficiency, shows shriveled yellow-brown leaves on which the tissue is dying back from the edge and a root half the size of a healthy one. The plant with insufficient phosphate, right, has a smaller root, shorter stalk, and over-size leaves compared to the well-balanced one in the center.

Sugar beets are heavy plant food users, requiring rich soil which they leave more or less exhausted. A ton of sugar beets removes from the soil approximately 4 pounds of nitrogen, 1.5 pounds of phosphate, and 6 pounds of potash. When grown on poorly fertilized land, they not only give small yield but also a sugar content often less than half that of beets test-grown from the same seed on well-fertilized land.

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When our capital city seemed . . .

A Potomac Pleasance

Jeff McDermid

(Elwood R. McIntyre)

WASHINGTON, D. C., fifty and more years ago, seemed a remote place of power and purpose, the cradle of American birthright; a city with a like refulgence of mystic mosques and minarets, often seen in shimmering vision by us of ordinary lives who sought a dream world of hope and glory.

This wonderland of song and story pictured beside countless country firesides was far beyond the ambition of those who followed the winding woodland pathway our families had made with valor through a trackless wilderness. We knew the national shrine was there, all right, on the flat lands of the Potomac, but few of us had the time, money, or reason to cross over the Appalachians to see "where Pompey passed the streets of Rome."

In awe and reverence, tinged with caustic humor, our fathers recited the hand-me-down legends and yarns that clothed actors of the Washington scene in duds of destiny, as they strutted their career stuff on the public stage.

We saw them pass by us in the smoke of pine knots and to the rollicking tunes of a cabin fiddler, warm and gleeful in his ample refreshments with noggins of applejack and buttered rum. As his rugged face shone with the sparkle of the blaze, we saw them all transformed by robust

language and lilting airs into a great company of statesmen, orators, soldiers, and heroes of rustic fancy.

We basked in the long dreams of winter evenings with the ones dressed in fringed pantaloons and leather jackets of the backwoods solons like Jackson, Fremont, and Crockett, mingling along rutty Pennsylvania avenue with cloak and dagger boys such as Arnold, Burr, and Booth; and lawmakers in stovepipe hats, long-skirted coats and baggy trousers worn by the Clays, Calhouns, Haynes, Websters, and Randolphs.

Then in our own more modern eyes we could also see their latter-day successors—Grant, Garfield, Harrison, and McKinley—elevated to places of extreme honor because of their activities afield in that era of regretful unpleasantness.

When I married, the tradition of Washington was augmented by my wife's own family history. Her grandfather was one of the virile Forty-Eighters who sought a fair haven in America after the scourge of Metternich and his associated sovereigns took ruthless toll on the liberty-loving Germanic people. Like the present-day Hungarians, they fled to a better land.

FROM THE UNFINISHED SHAFT TO GENERAL GEORGE . . .

Coming to our Midwest state as a green young immigrant, this grandsire and his parents and two sisters settled in a fertile prairie township. From there, at age 20 he enlisted in one of the early volunteer infantry regiments. His corps took part in every sizable engagement from the scene of brave Pickett's charge to the slough of despond known as the Wilderness.

While he saw Washington but once, it left an indelible mark on his memory. Reason enough, it was the Grand Review, when he and his host of battle-scarred, limping comrades trod every foot of the famous thoroughfare, from their bivouac on Capitol Hill almost to Foggy Bottom this side of Georgetown. And as Washington in those raw times let pigs and poultry roam at will, it was hard to keep those lusty foragers from breaking ranks to chase a shote or bag a fowl.

But my own relatives, including my father, served in the western theater. They never got a glimpse of the capital with its unfinished shaft to General George and the shabby, begrimed streets and buildings. To returning veterans generally, there was something in the spirit of it all which made this drawback of a shabby city seem well worth enduring hardtack, fever and ague, and hospital anguish to defend and maintain. That spirit, alone, added some intangible glory to the city of our government—at least, a glory not connected with political pomp and fanfare.

This, then, was the setting. Two young and alert persons with similar worship of a far-off patriotic shrine, but financially unable to indulge their wishes to behold the citadel of so much courage and devotion.

Yet, mental famines can be suddenly turned into a ravishing feast. After we had been married five or six years, the boss of our publishing outfit decided to send me East with the delegates to the World's Dairy Congress of 1923. Washington was included, and with it my first luxury ride on a crack train of the Baltimore & Ohio. Arriving with bulging eyes and eager feet, this scribe spent more time riding streetcars and walking through the Ellipse and the Mall than he did taking notes of the dairy doings in Memorial Continental Hall. My only regret was making the trip alone, with some of the details and glamour sadly lost in the excited descriptions carried back home.

In three years, another expense-paid chance to see Washington almost materialized. But just a week before starting time, the boss countermanded the order and sent me elsewhere—possibly to a swine show. As we had intended to have my wife go along, and we had already booked a place in her mother's home for our young offspring, this stroke of disappointment befuddled our plans. However, in the next ensuing summer vacation time I invited my wife to take the long-sought excursion to History Land.

. . . TO THE ROOT OF WESTERN PENNSYLVANIA AVENUE

Then and there I bravely borrowed two hundred whole dollars at the obliging bank on my personal note. We regarded that a real big splurge on rented funds. But looking back through the haze and glow of youth's sunsetting, I am convinced it was the best investment ever made on slim reserves since I paid the preacher to tie the knot. And no doubt it was the biggest of bargains as well. For please tell me how far on a 10-day hotel and eating-away-from-home jaunt at usual railroad rates could you get these days for two hundred dollars? And more revealing—I still clutched ten dollars when we got home, the last money we had left from the hoard my helpmeet kept fastened so securely in her rolled stockings.

Moreover, as a clincher to this all-out spending spree, that was our tenth wedding anniversary summer. Instead of going to Chicago for the World's Columbian Exposition, as so many of our older relations had done on similar occasions, we elected to see the Potomac Pleasance instead. We did it afoot and by sight-seeing bus, going as far as Alexandria southward, never dreaming that in another seven years we would be residents of the District, able to point, wave, direct countless visitors from home like old-timers show family treasures to their friends.

And so we two companions saw reminders of heaps of history in those six days in Washington over three decades ago. We were thrifty and selective. We did not hail a taxicab to move us and our two satchels. We hiked from the then new Union Station on the Plaza by way of Delaware Avenue and other circles to the root of western Pennsylvania Avenue at the Grant Memorial statue. From here we took uneven sidewalks, sadly disturbed over all the litter in the streets and the rows of

cheap palmist and horoscope parlors lining the north side of the Avenue of Presidents.

On the opposite side into the lower Mall were those rough, wooden barracks that held the extra workers during World War I. The famous Federal Triangle was then nonexistent. Looking hard for a modest hotel catering to economical patriots without government vouchers to sign, we landed in a white brick place on D street, not far from the avenue, once the stopping spot of many famous and infamous characters who moulded or marred the pages of history. I remember it as the United States Hotel.

To the present active generation, our pilgrimage would seem like a visit to some unfinished dream, an easily satisfied glimpse of a city still emerging from chaos and hodgepodge architecture, a city trying hard to avoid looking back to the mistakes and tragedies it ought to forget. For we were there before such features as Constitution Avenue, National Gallery of Art, National Archives, New Post Office Department, Internal Revenue Building, Department of Justice and its gangster relics, Jefferson Memorial, the whole Department of Agriculture's behemoth buildings, and the Labor Department facing them.

FROM WASHINGTON IN THE GREAT DEPRESSION . . .

But the parks were there, the mocking birds were singing in the magnolias, the sun shone on wide, green vistas, and we felt the balmy air from Dixie brushing our eager faces as we stood high on the solemn grounds of Arlington—looking wistfully down the peaceful Potomac, where we finally went to see Mount Vernon, via the decrepit, rattling electric cars, long since discarded.

Yes, we were "kids" then who lived in a bright, new world. This was a great experience for us—ten days of delight; days of holding no grudges against Washington City for the errors it had harbored and permitted while the nation felt its growing pains. They were days of calm faith in the ultimate truth and justice of this country.

Within a few years our little family migrated to Washington at the behest of hard times, wide misery, unemployment. For Washington in the Great Depression was primarily a city of refuge. Anyone who had any sort of recognition and favor in the new party, put into power to run a series of bold experiments in political economy, could at least maintain self-respect and warm his toast amid the bread lines.

Against a total cut in the federal payroll of about 20 per cent, those of us who transported our kindred to the national capital to exist temporarily otherwise would have faced a 100 per cent blackout. Jobmasters set up political screening offices to vouch for those standing in long lines to get appointment slips which gave them a desk with many others in crowded emergency agencies. To many of us, this government largess

was the last resort on this side of stark, callous relief doles.

After finding a four-room apartment on New Hampshire avenue and buying some second-hand furniture, we located the girls in District schools in walking distance. Then we began to see the city of our pride in a new light. In place of the dream, we knew the reality; in place of the glamour of soldiery, we saw the soddenness of commercial stagnation creeping to the edge of our oasis; instead of security as the stimulus of national pride, we saw major economic treatments and surgical operations performed on our body politic by desperate men, elected to a difficult leadership. We were caught in the midst of a maelstrom of terrific adjustment for a long term of trial and error.

Congressional oratory survived—and had many new recruits. Oratory even gained credence and attention, more than it had often failed to do in the easier, flowery years of normal life and living. This new fountain of rhetoric was let loose against all lawmakers who were timid or tardy. It helped to make them see that all the pioneering of a physical kind that had gone before in our history was now returned to demand new roads and bridges across the quicksands of our sunken spirit.

. . . TO THE HIGH CONGRESSIONAL GALLERIES

While I was busy wrestling with those abstruse and enigmatical lessons given out on practical and impractical doctrines, for which the weary public was looking with skepticism, my folks had a different viewpoint. My wife and girls found their favorite educational source in the high congressional galleries. Here they listened to the best and the worst of it, thankful and not a little awed perchance, at this golden opportunity to see the interplay of comedy and tragedy in the spotlight of the national stage.

It was no mean company that trod the boards of dramatic legislation in the mid-thirties. There was Hugo Black and John S. Bankhead of Alabama; the fluent and eloquent Henry F. Ashurst of Arizona; Hiram W. Johnson of California; William E. Borah, heavy-browed foreign affairs chairman; "Jim Ham" Lewis of Illinois, with nicely turned phrases; W. B. Schall of Minnesota, led by his seeing-eye dog, "Lux," whose obituary got into the Record; Kentucky's celebrated and "only," Alben W. Barkley; Louisiana's truculent and filibustering hero, Huey P. Long; Michigan's clean-cut pair, James Couzens and Arthur W. Vandenberg; George W. Norris, famed Nebraska progressive; Montana's duet, Thomas J. Walsh and Burton K. Wheeler; Oklahoma's Thomas P. Gore; Jimmy Byrnes of South Carolina; august Reed Smoot of Utah; the brilliant financial wizard, Carter Glass of Virginia; and that notable son of a distinguished father, Robert M. LaFollette, Jr., of Wisconsin.

Over in the House gallery, our girls, with their mother to sharpen them up, saw and heard many, such as Mr. Steagall and William Bank-

head of Alabama, Mr. Vinson of Georgia, Mr. LaGuardia of New York, Marvin H. Jones of Texas, agriculture chairman, and Speaker Henry T. Rainey of Illinois. They had some prominent associates sitting right in the galleries too, for once they saw Will Rogers absorbing the scene, and at another time Mrs. Nicholas (Roosevelt) Longworth. There they also often saw the redoubtable Mr. Townsend, trying to set in motion his scheme of perpetual paradise for the aged through actuarial miracles. Possibly those elderly lobbies of the thirties laid foundations for the old-age and survivors' insurance system and amendments of today.

Leaving this vantage point in the lawmaking halls, our femine trio spent many happy hours in the Washington Zoo. Here one of the features never missed was the little black, ruby-crowned Hill Myna bird. Some past M. C. had donated it to the Zoo, after teaching it to say: "Well, folks, how about the appropriation?"

Massing of the colors of all nations at the great, unfinished cathedral on Mt. Saint Albans; rides on the old barge canal; car trips through bosky dells and deep, river-cut ravines to Cabin John and Glen Echo; picnics and horseshoe-pitching parties above the foaming Potomac Falls; a special boat ferry to Analostan Island, where old race tracks were dimly seen as relics of an abandoned pleasure park; going down to the Marine Barracks in southwest areas to hear swinging, booming marches on lovely summer evenings in memory of olden valor and the artistry of that native of the District—John Phillip Sousa.

Then the great Lincoln marble, work of that other Washington son, Daniel Chester French, attracted us again and again. We imagined that one side of that dignified, pioneer-American, highboned face wore a twinkling smile about old jokes forgotten, to offset the mournful, deep loneliness the other side presented as you gazed aloft.

Standing there on the steps, we imagined again how slow the weary marchers went, how distant gunfire ceased, how the veterans returned, how the carnage was ended, how the wounds were slow to heal; how the bright morning rose up over the Shenandoah to shine again on the winding stream, the meandering Luray Valley roads, softly leading to the haunted hideaways of Stonewall Jackson's men.

Going afield southwesterly, we, too, saw the rough, the rocky, the rawboned places where confident Confederates broke the battered ranks of untrained invaders, to send them scattering like turkeys back beyond Cub Run and Sudley's Ford. We four tramped the tall, wild grasses and traversed the ground around the drab old Henry House. Our only guide was a simple local man. He had himself stuck in the laths on the land at strategic points made famous for the grit and dash of those who rallied behind Bee and Bartow, Pelham and Ricketts in this first great clash between brothers. Our visit was made long before the verdant parklike swales and hillocks took on the formal dress now worn for curious onlookers.

Thus our interval in Washington while the kids were little and easy to impress was the best time we ever had there. It's because we saw all things doubly and more thoroughly, using our own senses and the awakening senses of our girls. It's true we returned once more at another time to live among those sights of wonder and renown. But meantime, Washington had become an international scene, a city of destiny for many nations, and a solace to many foreigners in trouble.

The old build-up based alone on indigenous patriotism, on domestic problems and solutions, on popular echoes from the pioneers—this was mostly gone and a big, new, wide-world-vista had opened on the horizon of Washington City. There wasn't much you could do to get back the old backwoods spirit and fierce independence. And you did not want to try very hard. Cries of America for the Americans always force us to ask, ". . . and who are these Americans, anyhow?"

Yes, it's good to have known that original dream; to have been part and parcel of a tribe that helped fix it into the frame it wears in the galaxy of nations. If we had had no long experience with the good and the bad, the smooth and the rough, with self-reliance and cooperation blended, it is a cinch our land would not be the force for peace that it represents.

COMBINATION GETS RESULTS . . . AND PROFITS

IT takes a combination of good farm practices to get the most profit from fertilizer, R. H. Blosser concludes from data on four levels of corn fertilization.

The Ohio State University Agricultural Economist's figures show that 600 pounds of fertilizer give an average profit of $63 an acre on farms with excellent production practices. On farms with poor practices, 600 pounds of fertilizer give a profit of only $8 an acre.

Increasing the fertilizer rate to 800 pounds gives a profit of about $65 with the best farm practices while with the poor practices, profits drop to $3 an acre.

Two hundred pounds of fertilizer return $32 an acre with the best practices, but result in a loss of about $10 an acre on farms following poor practices. A 400-pound fertilizer application gives a $55 profit on farms with the best practices and only $6 an acre with the poor practices.

Blosser says farmers following excellent practices use a soil-building rotation. They also plant corn on time, using the recommended amount of high-yielding adapted seed. They lime according to soil test, control erosion and have the fields well-drained.

The specialist urges farmers to improve their other cropping practices to get the most returns from commercial fertilizer. He says each farmer needs to check his own farm to get the best rate of fertilizer for the most profits. Soil tests are a good guide for this, he adds.

Fig. 1. On this soil low in potassium in Iowa 27 lbs. of K_2O as muriate of potash beside the row at planting gave more rapid early growth and greatly increased yields of corn.

POTASH FERTILIZERS And Their Behavior

By Werner L. Nelson • **Lafayette, Indiana**

CURRENTLY in certain sections of the country there appears to be more than normal interest in the question of potassium carriers as well as methods of applying potassium fertilizer. In view of this, a brief summary of some of the experimental work and thinking on certain aspects of the problem will be given.

Potash Carriers

The carriers of potash vary in the accompanying anion. Some of the carriers are in Table I.

Potassium chloride (muriate of potash) thus is the major source of fertilizer potassium consumed in the United States. Sulfate of potash and sulfate of potash-magnesia make up almost all of the remainder.

Except for certain specialized crops one potash carrier is as effective as any other. The quality of tobacco, and in some instances potatoes, is affected adversely by excessive amounts of chlorides. Of course these crops may require from 100 to 300 lbs. or more of K_2O per acre annually. In such in-

TABLE I.

	K_2O content	Usage in U. S.
Potassium chloride	60–62%	94%
Potassium sulfate	50%	6%
Sulfate of potash-magnesia	22% (18% MgO)	
Manure salts	22–27%	Trace
Potassium nitrate	44% (13% N)	—
Nitrate of soda and potash	15% (15% N)	—
Potassium phosphates	30–50% (32–53% P_2O_5)	—
Potassium carbonate	15–65%	—
Potassium metaphosphate	35% (55% P_2O_5)	—

stances sulfate of potash may furnish a portion or all of the potash. It is of interest, however, that in Holland muriate of potash is broadcast in the fall preceding the spring planting of potatoes. Presumably this method allows for the leaching out of the chloride by fall and winter rains.

Anion Balance in the Plant

Considerable emphasis has been placed on cation balance in plants. Each plant species appears to have a rather specific capacity to hold just so many cations. When this capacity is used up by high quantities of one cation, one or more of the other cations may be present in deficient amounts.

Questions have likewise been raised concerning the balance among the anions in plants. The important anions are $H_2PO_4^-$, NO_3^-, $SO_4^=$ and Cl-. In addition there are the carbonate and silicate ions. Soil studies by Ohlrogge and

Fig. 2. On this soil low in potassium in Illinois 60 lbs. of K_2O as muriate of potash beside the row at planting increased the yield of soybeans 10 bushels per acre.

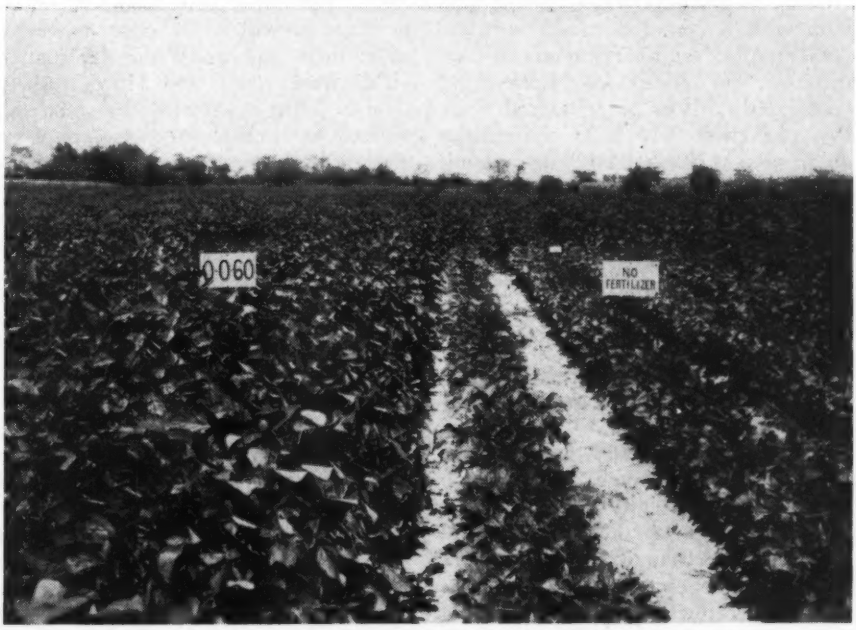

Fig. 3. Wheat responded to potash in the drill on this low potassium soil in Illinois (right). Twenty pounds of K_2O increased the yield 11 bushels per acre.

Duncan at Purdue (1956) reveal that salts with a common cation such as potassium but with varying anions vary in effect on phosphorus uptake by young corn plants as measured with P_{32}. Likewise salts with a common anion such as chloride but with varying cations vary in effects. In general their results indicate that phosphorus uptake with potassium salts tends to be as follows: $H_2PO_4 > SO_4 > Cl = NO_3 > HCO_3$. With cloride as the common anion phosphorus uptake tends to be as follows: $Na > K > H > Li$. These workers point out however that early effects might be quite different from final effects.

Meyer, Warren, and Langston at Purdue, 1956, worked with young tomatoes in sand cultures using P_{32} as a measure of the uptake of phosphorus. With phosphorus uptake in the presence of the sulfate ion equal to 100%, the chloride treatment gave an uptake of 78%. Just what this means in terms of plant growth is not clear, however, as in their experiment the dry matter yields were 100% and 115%, respectively. Thus in spite of the small decrease in phosphorus, yields were slightly higher with the chloride treatment.

Measurement of total phosphorus in plants at bloom or at maturity has shown somewhat different results than obtained with young plants. Corn in Minnesota and oats in Illinois showed no effect of potassium chloride on total phosphorus (Table II). The phosphorus in alfalfa and oats in the greenhouse was slightly reduced, however.

Unpublished work by W. H. Pierre at the West Virginia Agr. Exp. Station on corn in the intermediate stage of growth reveals little effect on total phosphorus content with rates up to 630 lbs. K_2O (Table III). On the other hand chloride content was increased

10-fold. Sulfur content was reduced somewhat with increasing rates of KCl.

Corn plants tend to restrict chloride accumulation in the leaves to relatively low levels or about 0.7% (20 mgm. eq.). On the other hand chlorides in tobacco may exceed 6%.

Effect of Potassium on Maturity

The time from silking to maturity in corn is fairly constant regardless of treatment but the time between planting and silking can be shortened by soil treatment according to work reported in Iowa Farm Science, 1952. Nitrogen, phosphorus and potassium all hasten the date of silking on soils deficient in these elements. Fifteen and 30 lbs. of K_2O in the fertilizer at planting hastened maturity 10 days on a soil quite deficient in potassium. On soils rating medium or above, potassium had little effect on maturity.

On soils low in potassium in New York (Younts, 1956) 20 lbs/A of K_2O as potassium chloride in a complete fertilizer in the row gave corn a quicker start and brought about earlier tasseling and silking than starter fertilizer without potassium. Broadcasting the same amount of potassium was not as effective.

Under dry conditions improper placement of fertilizers high in nitrogen and/or potassium may delay germination or plant growth and result in delayed maturity. This can be remedied by accurate placement as will be mentioned later.

TABLE II.—EFFECT OF POTASSIUM ON PHOSPHORUS CONTENT OF PLANT MATERIAL. NORTH CENTRAL REGIONAL PUBLICATION NO. 67 (SOUTH DAKOTA AGR. EXP. STA. BUL. 453, 1955).

	K_2O added lbs./A	% P	
		P	P+K*
Oats (Ill.)	50	.402	.400
Oats (Ill.)	50	.368	.387
Corn (Minn.)	20	.252	.259
Corn (Minn.)	20	.220	.214
Corn, Alfalfa, Oats (Greenhouse)	20	.244	.237
	20	.334	.319
	20	.508	.486

* K as KCl applied with phosphorus fertilizer.

Chlorides as Compared with other Forms

Chlorine an essential element. Studies in California (Stout et al., 1956) have shown chlorine to be essential in plant growth. Small amounts are required, however, and as yet the extent of deficiency in agricultural areas is not known. It is of interest that work with flue-cured tobacco suggests that around 20 lbs/A of chloride should be applied.

Moisture content of the plant. The anion associated with potassium has a definite effect on moisture content of

TABLE III.—EFFECT OF RATE OF POTASSIUM CHLORIDE ON CHLORIDE, PHOSPHORUS, AND SULFUR CONTENT OF CORN PLANTS (W. H. PIERRE, WEST VIRGINIA AGR. EXP. STA.)

K_2O* lbs/A	Mgm. eq. per 100 gm dry matter				Yield
	K	Cl	P	S	gm/pot
0	19.3	2.1	3.1	4.6	70.7
63	20.6	6.4	3.0	3.6	78.7
315	29.6	12.2	2.8	2.5	82.0
630	40.5	20.0	3.0	3.0	87.9

*Added as KCl to 1/10 of the soil in a vertical cylinder in center of pot.

the plant. The chloride tends to encourage greater water content. Data obtained by Meyer, Warren, and Langston at Purdue, 1956, shown in Table IV, are perhaps rather typical:

TABLE IV.

	Per cent H_2O in young bean plants
Check	87.3
Sulfate	88.2
Di-hydrogen phosphate	89.2
Nitrate	89.7
Chloride	91.5

This effect of chloride has been observed many times in potato tubors in comparisons between sulfate and chloride sources of potassium. Moderate amounts of chlorides are believed to play a role in affording protection against drought in certain crops such as tobacco and lettuce.

Behavior in the soil. The sulfate ion is retained more strongly in the soil than is the chloride ion. Sulfate may combine with the calcium to form the less soluble calcium sulfate and it also may be adsorbed by certain of the hydrous aluminum oxides. Such mechanisms tend to take the sulfate out of circulation. Chlorides or nitrates are adsorbed by the soil to only a very small extent.

Salt index. Nitrogen and potassium salts in fertilizers increase the salt concentration of the soil solution. The term, "salt index," is used to refer to the concentration and is determined by placing the material in soil and measuring osmotic pressure. The higher the value the more likely the particular carrier will injure plants if placed close to the roots.

There is considerable difference in the salt indices of the potash carriers, as shown in Table V.

TABLE V.

	% K_2O	Salt index* per unit of K_2O
Manure salts	22–27%	5.636
Sulfate of potash-magnesia	22%	1.971
Potassium chloride	60–62%	1.936
Potassium nitrate	44%	1.580
Potassium sulfate	50%	.853

* Rader, White, and Whittaker, Soil Sci., 1943.

Manure salts, a source low in potash and made up of KCl and NaCl, has an extremely high salt index per unit of K_2O. Potassium sulfate is low and potassium chloride is intermediate. Sulfate is divalent while chloride is monovalent. Hence there are only half as many anions in sulfate for a given quantity of potassium and this helps to make for the lower salt index. Sulfate of potash-magnesia is a mixture with magnesium sulfate. Hence there is a rather high amount of soluble salt per unit of potash and the salt index is about the same as for potassium chloride.

Stands. From the above it might be suspected that with a placement critically close to the seed or plant, potassium sulfate would give less trouble than potassium chloride. Meyer, Warren and Langston at Purdue, 1956, concluded this in field studies with tomatoes at rates of 200, 400 and 800 lbs. of salts per acre. The carriers were placed in an 8-inch furrow, covered, and tomato plants set with roots about 2 inches above the fertilizer. At the higher rates stands and plant weights were greater with potassium sulfate than with potassium chloride. Ammonium sulfate was just as detrimental as potassium chloride, however, indicating that the accompanying cation has an effect. Placement of the salts in bands to the side would of course have helped eliminate differences among salts.

Fertilizer Placement

Much of the preceding discussion serves to emphasize the importance of proper fertilizer placement. It is well known that soluble nitrogen and potash salts in close proximity to the seed may be detrimental to the germinating seed and young plant. Following the principles of sound fertilizer placement will eliminate the soluble salt problem.

Proper placement is important for several reasons including:

1. Prevention of injury to the plant;
2. Efficient utilization by the plant;
3. Convenience to the grower.

Grade changes. In 1949 2-12-6 was the most popular grade in the Midwest. In 1957 4-16-16 and 5-20-20 will be among the most important as a row fertilizer for corn. The 2-12-6 has a total of 8 units of N plus K_2O while the 4-16-16 and 5-20-20 have 20 and 25, respectively. The trend toward higher analysis goods is desirable and will continue but the greater salt effect must be recognized. Improved placement methods must be adopted to avoid injury and realize the greatest benefits from applied fertilizers.

Split-boot and band placement. In spite of the trend toward higher analysis and also higher rates of fertilizer the same application equipment is being used today as in 1949—namely, the split boot. This often places the fertilizer above the seed level and/or very close to or with the seed. In dry springs such a placement has been harmful to stands of row crops. On the other hand, the phosphorus does not move and is in a relatively ineffective position as far as the plant roots are concerned. Compactness of the seedbed and speed of planting, of course, affect very greatly the exact position the split boot will deposit the fertilizer.

The importance of placing the planting fertilizer in a band to the side of and below the seed has been recognized for many years. (See fig. 4.) In

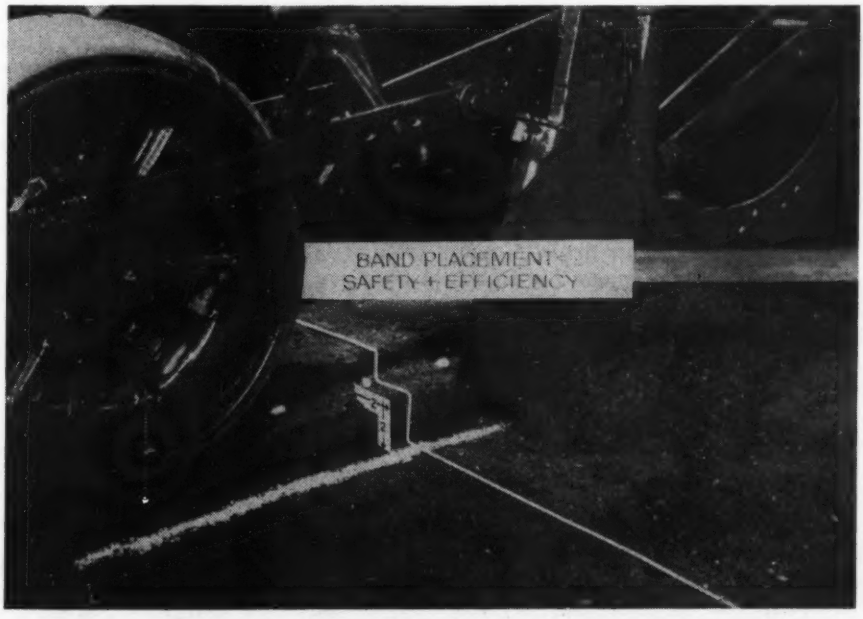

Figure 4. Placement of row fertilizer to the side of and below the seed is important for row crops such as corn and soybeans. This helps to avoid damage from soluble salts in high analysis fertilizers and makes for efficiency because the phosphate is placed in the root zone rather than near the surface.

1948 the National Joint Committee on Fertilizer Application stated that the fertilizer for corn should be "drilled in a continuous band approximately 2 inches to one side of the row about 2 inches below the level of the seed." Most of the major farm implement companies make equipment that will do this satisfactorily. Michigan and Kansas authorities state that the split-boot applicator largely used on conventional corn planters is not satisfactory.

Work by MacGregor and Johnson in Minnesota illustrates the importance of band placement. Two-year average results with three methods of application of 200 lbs. of 5-20-20 are shown in Table VI.

TABLE VI.

	Increase in yield of corn bu/A
Standard split boot	6.8
2" below and 2.5" one side	10.7
2" below and 5" one side	7.7

Proper placement gave 3.9 bushels more corn. Whether this increase is due to placing the phosphorus in a more accessible position, to less salt damage, or a combination of the two is, of course, not known. In dry years the difference may be even greater.

Recommendations are made in many states for maximum amounts of soluble salts at planting for a row crop such as corn. In the Midwest, Ohio and Indiana suggest a maximum of 60 lbs. of N + K_2O while Iowa suggests a maximum of 45 lbs. as a row or 30 lbs. as a hill application. The lower value in Iowa is understandable in view of the drier conditions which are likely to be encountered after planting. In most instances split-boot placement is the standard in such recommendations. It obviously would make a great deal of difference in the top amounts if the band method rather than the split boot was used. In many instances much higher amounts are being used at planting for corn and other row crops if the fertilizer is placed in bands.

Row and broadcast application. In most instances the potash is applied in the row fertilizer at planting. With the increased interest in soil testing more and more soils low in potassium have been found. On such soils corrective applications of potassium are recommended. If the amounts are very large most states suggest that at least part be broadcast.

It is generally recognized, however, that on a soil low in potassium there should be potassium in the row fertilizer even if large amounts are broadcast. Results on corn from Illinois, shown in Table VII, illustrate the point (P. E. Johnson, Univ. of Ill., Ag-1534, 1952).

At the first two locations 54 lbs. of K_2O in the fertilizer at planting gave substantial increases in yield. At the other two locations extremely dry conditions prevailed in 1952.

TABLE VII.

Fertilizer at Planting* N + P_2O_5 + K_2O	Yield of corn-bu/A			
	Farm No. 1	Farm No. 2	Farm No. 3	Farm No. 4
8+32+0	77	79	64	41 bu.
6+18+54	89	88	57	37 bu.

* 150 lbs. K_2O and 60 lbs. N broadcast on all plots; soils low in potassium.

An illustration of the combination of broadcast and row application of fertilizer, in Table VIII, is taken from Purdue recommendations on a soil testing low in phosphorus and potassium for a corn-soybean-wheat-hay rotation. (155 lbs. P_2O_5 and 235 lbs. K_2O needed in rotation).

TABLE VIII.

Corn.....	0+90+180 5+20+20	Broadcast In row
Wheat.....	10+40+40	In row

Illinois recommendations suggest maintaining the supply of potassium by broadcast applications once or twice in the rotation. Purdue recommendations state that row applications are not necessary if sufficient potash is broadcast in the rotation.

When ordinary amounts of potash are being applied the farmer may find it most convenient to include the necessary potash in the mixed fertilizer at planting. Too, in some instances more efficient results may be obtained with row application. Ohio workers at Wooster studied the effects of row placement and broadcasting 48 lbs. of K_2O. Two-year results showed row placement gave 89.3 bu. of corn per acre while broadcasting gave 79.8 bu. Nitrogen and phosphorus were included in the row in both comparisons. Work in Indiana has shown that 30 lbs. K_2O in the row is more effective in increasing the % K in the corn leaf than 50 lbs. K_2O broadcast.

Summary

1. Many studies have indicated that for most crops the various potassium carriers are essentially equal from the standpoint of crop response and yields. If the chloride ion was consistently detrimental, it would have shown up in experimental work during the last 50 years. Such has not been the case. With certain specialized crops such as tobacco and sometimes with potatoes a non-chloride form of potash is used to supply all or part of the K_2O needs.

2. Evidence with regard to anion balance in plants is conflicting. Some work has indicated that with young plants increasing the level of chloride in the soil may result in a reduction in uptake of phosphorus. Analyses of mature plants have usually failed to show any effect of increasing rates of chloride upon phosphorus absorption. There has been no indication early reduction affects final yields.

3. On deficient soils potassium in the starter fertilizer hastens the silking date of corn. On soils medium to high there is little effect. The positive effect on yields from potassium in starter fertilizer is well known.

4. There is considerable difference in the salt indices of the different potash carriers. Potassium chloride (muriate) has a salt index double that of potassium sulfate. If chloride forms of potash are not placed properly with reference to the seed, one would expect them to have a more harmful effect upon germination and seedling growth than sulfate forms.

5. Chloride forms of potash are the cheapest from the standpoint of cost per unit of K_2O and, with all except specialized crops where certain quality factors must be considered, will give results equal to those obtained with other forms of potash. The higher salt index of muriate, however, emphasizes the need for proper placement.

6. The use of higher rates of more concentrated fertilizers in recent years emphasizes the need for giving more attention to proper fertilizer placement.

7. Band placement of row fertilizer to the side of and below the seed is superior to split-boot placement. Where large amounts of potassium are required it may be necessary to combine row and broadcast application.

8. It should be kept in mind that use of potassium as well as nitrogen, phosphorus and lime is far below that needed for maximum profit.

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Variation In Composition Of Pecan Leaves

SOME IMPORTANT SOURCES

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FOR the past 15 years leaf analysis has been used in conjunction with field experiments involving various fertilizer applications and different cultural practices. Reports in the literature show that leaf analysis surveys of various crop trees are valuable once the respective critical levels for the essential elements in the leaves are established.

It was hoped that critical levels of the various essential elements in the leaves of pecan trees could be established as criteria in surveying orchards in large areas for suspected nutrient deficiencies. However, in studies of pecans a very high degree of variation in composition, especially of certain essential elements, was encountered, and it was very difficult to produce significant differences in the composition of leaves by the application of certain fertilizer materials to the soil. It is the purpose of this report to describe some of the variations which have made it more difficult to establish a reasonably reliable base for use in leaf analysis surveys with pecan than with some other crop trees.

Type of Shoots

Early in the studies it was recognized that pecan trees vary greatly in the proportion of bearing and non-bearing shoots. Even in a heavy crop year some shoots do not bear nuts. In order to establish a reliable base for sampling, four trees from each of four fertilizer treatments in a larger experiment were selected for sampling bearing and non-bearing shoots in September. The treatments consisted of am-

monium sulfate, cyanamid, complete (NPK) fertilizer, and no fertilizer. It was later established that some of the trees were deficient in phosphorus and potassium (2) and this may have caused the differences in the data obtained from the two types of shoots to be somewhat larger than might occur with more nearly normal trees.

The data on the nitrogen, phosphorus, potassium, calcium, and magnesium contents of the leaves are summarized in Table I. Nitrogen, phosphorus, potassium, and magnesium were significantly lower in the leaves from bearing shoots than in those from non-bearing shoots on the same trees. The calcium contents were not affected. These data show that the type of shoots sampled is important and may be a source of error if care is not exercised in sampling. It is often difficult to determine with any reasonable degree of accuracy the proportion of bearing and non-bearing shoots on a large pecan tree; if possible, only leaves from bearing shoots should be selected for sampling because they are more likely to be of the same physiological age. Non-bearing shoots often make vegetative growth later in the season than bearing shoots.

TABLE I.—MEAN CHEMICAL COMPOSITION (DRY-WEIGHT BASIS) OF MOORE PECAN LEAVES FROM BEARING AND NON-BEARING SHOOTS SAMPLED IN SEPTEMBER.

Type of shoots sampled[1]	N	P	K	Ca	Mg
	%	%	%	%	%
Bearing	2.32[2]	0.105[2]	0.44[2]	1.82	0.466[2]
Non-bearing	2.32	.120	.52	1.85	.502

[1] Sixteen trees were sampled, four from each of four differently fertilized plots.
[2] Significantly lower than for non-bearing shoots at .01 level.

Time of Sampling and Crop Condition

The group of trees described under type of shoots was sampled in June and September for three consecutive years; in two of these years the trees were supporting a heavy crop of nuts and in the other they had no crop. The data on the nitrogen, phosphorus, potassium, calcium, and magnesium contents are summarized in Table II. An examination of these data shows that the samples taken in September were more useful in identifying deficiencies of nutrients than those taken in June, especially in 1943 and 1945, when the trees were supporting heavy crops of nuts. From June to September, in both of these years, there were statistically significant decreases in the nitrogen, phosphorus, and potassium contents of the leaves; but in 1954, when the trees were supporting no crop, the only significant decrease was in potassium content.

If one had sampled these trees in 1944, but not in 1943 and 1945, it is questionable whether deficiencies of phosphorus and potassium would have been suspected. The data for 1943 and 1945 clearly pointed out that there was a shortage of these elements in some of the trees (1, 2, 3). Thus, it is important that the crop condition on the trees be considered if data from leaf analysis are to be of maximum value in determining probable deficiencies in pecan trees. As a matter of fact, the variable crop load on pecan trees which is common introduces one of the main sources of the variation which has been very troublesome in conducting nutritional studies. One not recognizing this fact could easily reach the wrong conclusion when interpreting leaf analysis data.

TABLE II.—MEAN CHEMICAL COMPOSITION (DRY-WEIGHT BASIS) OF MOORE PECAN LEAVES SAMPLED AT DIFFERENT TIMES WHEN CROP WAS HEAVY OR MISSING

Sampling dates[1]	Crop condition	N	P	K	Ca	Mg
		%	%	%	%	%
June 1943	Heavy	2.63	0.166	0.99	1.27	0.45
September 1943	Heavy	2.23[2]	.106[2]	.44[2]	1.82[3]	.47
June 1944	None	2.32	.139	1.05	1.23	.43
September 1944	None	2.34	.137	.78[2]	1.69[3]	.39
June 1945	Heavy	2.59	.148	1.01	1.38	.42
September 1945	Heavy	2.11[2]	.099[2]	.35[2]	1.80[3]	.44

[1] Sixteen trees sampled, four from each of four differently fertilized plots.
[2] Significantly lower than for June samples at .01 level.
[3] Significantly higher than for June samples at .01 level.

Phosphorus and Potassium Applications

In 1947, after it had been established that deficiency levels of phosphorus and potassium occurred during the development of a heavy crop of nuts, an experiment was set up to measure more clearly the effects of soil applications of these elements on the production of quality nuts (4). Eighty trees of the prolific Moore variety were selected to accommodate a split-plot factorial experiment with two levels of phosphorus (0 and 10 pounds per tree of P_2O_5) and two levels of potassium (0 and 10 pounds per tree of K_2O) under two systems of culture. Nitrogen was supplied through the growth of blue lupine, and this crop was cultivated into the soil in one series of plots and mowed and left as a mulch on the surface in the other.

The two types of culture were abandoned in 1952, after weather conditions had caused a failure of the blue lupine sown in the falls of 1950 and 1951. The fertilizer treatments were modified at the same time by adding magnesium sulfate to the soil of appropriate plots to change the fertilizer treatments into a factorial of phosphorus, potassium, and magnesium. The data on the yield of nuts and the phosphorus and potassium in the leaves for the two levels of phosphorus and two levels of potassium are summarized in Table III. Similar data are not included for magnesium because it was not used throughout the experiment and no measurable effects of the applications had developed from its introduction to the end of 1954.

The applications of phosphorus and potassium fertilizers had no noticeable effect on yields of nuts. Applications of phosphorus fertilizers increased the phosphorus in the leaves significantly by 1950, and the effect became more pronounced as the experiment was continued; but only in 1953, the seventh year of the experiment, did the potassium applications increase the potassium content of the leaves significantly. The variations in the levels of these elements in the leaves as related to seasons were much greater than those related to fertilizer applications. Moreover, the contents of these elements in the leaves were higher in 1947, after one application of the fertilizers, than in the years that followed, except for potassium in 1953. Similar seasonal differences have been noted before and attributed to the crop load on the trees.

The yield records for these trees indicate that some factor or factors other than crop load must have been responsible for the differences in the phosphorus and potassium levels.

TABLE III.—YIELD OF MOORE PECAN TREES FERTILIZED WITH PHOSPHORUS AND POTASSIUM FERTILIZERS OR UNFERTILIZED AND PHOSPHORUS AND POTASSIUM CONTENTS OF THE LEAVES (DRY-WEIGHT BASIS).[1]

Year	Yield per tree with				P in leaves with		K in leaves with	
	No P	P	No K	K	No P	P	No K	K
	Lb.	*Lb.*	*Lb.*	*Lb.*	*%*	*%*	*%*	*%*
1947[2]	130	130	134	126	0.136	0.144	0.84	0.88
1948[2]	81	85	81	85	.106	.108	.65	.70
1949[2]	69	68	72	66	.108	.103	.71	.78
1950	121	125	118	128	.091	.101[3]	.54	.60
1951[2]	81	86	85	81	.089	.100	.56	.71
1952	152	152	152	152	.100	.109[3]	.63	.77
1953	93	101	96	98	.108	.122[3]	.82	1.04[4]
1954	84	80	76	88	.107	.125[3]	.59	.70

[1] Mean values based on 40 trees for each treatment.
[2] Composite samples were analyzed; for other years individual tree samples were analyzed.
[3] Significantly higher than for no P at .01 level.
[4] Significantly higher than for no K at .05 level.

Higher levels of these elements were found in the leaves in 1952, following the failure of the lupine in 1950 and 1951, than in 1950, despite the fact that the 1952 crop exceeded the 1950 crop by some 20 pounds of nuts per tree. This leads to the suspicion that the reduced nitrogen supply might have been a contributing factor. Then, too, the rainfall was much lower during the last four years of the experiment than in the first four, and as pointed out in a previous paper (4), the trees made exceptionally large increases in cross-sectional areas of the tree trunks during the early years of the experiment. Low nitrogen and moisture supplies during the last four years may have reduced the utilization of phosphorus and potassium below the potential had more nitrogen and moisture been available.

Throughout this study it appeared that leaves of some trees tended to be consistently high or low in phosphorus and/or potassium in different years. Since data from individual trees were available for 1950, 1952, 1953, and 1954, all possible linear correlation coefficients (r) were calculated to see how consistent these apparent relations were and to determine to what extent the applications of fertilizers had influenced them. The correlation coefficients (r) between years for phosphorus with phosphorus and potassium with potassium are listed in Table IV.

The correlations between years for leaves of trees receiving no phosphorus in the fertilizer show that there was a

TABLE IV.—CORRELATION COEFFICIENTS (r) BETWEEN YEARS FOR PHOSPHORUS WITH PHOSPHORUS AND POTASSIUM WITH POTASSIUM IN LEAVES FROM FERTILIZED AND UNFERTILIZED MOORE PECAN TREES FOR 1950, 1952, 1953, AND 1954.[1]

Years for which values were correlated	r for P with P for trees with		r for K with K for trees with	
	No P	*P*	*No K*	*K*
1950 with 1952	0.41	0.30	0.63	0.75
1950 with 1953	.45	.22	.09	−.14
1950 with 1954	.48	−.15	.62	.72
1952 with 1953	.44	.63	.00	−.16
1952 with 1954	.28	.72	.69	.82
1953 with 1954	.08	.46	−.02	.04

[1] A value for (r) of 0.41 or higher has high significance.

definite tendency for leaves with either high or low phosphorus one year also to have high or low phosphorus in other years. However, this relation did not continue in the comparisons of 1952 and 1953 with 1954. The correlations between years for the trees receiving phosphorus in the fertilizer indicate that there was less tendency for trees to repeat the levels in the early years of the experiment, but a decided tendency for them to do so in the later years. Phosphorus in the leaves from trees receiving phosphorus in the fertilizers was increased significantly over that in the leaves from trees receiving no phosphorus, especially in the last three years, and the high correlations found for those years indicate the influence of the fertilizers.

The correlations between years for leaf potassium indicate that the individual trees repeated with either high or low potassium to a highly significant degree in the alternate "on-years" of 1950, 1952, and 1954. Despite the fact that the yields were lower in 1954 than in 1953, the number of nuts on the trees was much greater in 1954. (The severe drought of 1954 prevented the potential yield from developing.) The correlations of the "off-year," 1953, with the "on-years," 1950, 1952, and 1954, indicate that the potassium in the leaves in 1953 was in no way related to the potassium in the leaves for the other three years. It appears that potassium in the leaves follows the production cycle to a very high degree and that the higher potassium in the leaves in 1953 was not reflected in the potassium in the leaves in 1954. Applications of potassium fertilizers had very little effect on the seasonal cycle of potassium in the leaves, but the higher correlations for the trees receiving potassium fertilizers indicate that the applications did exert some influence.

Variety

Sharpe and Gammon (5) reported on the difference in the composition of leaves from trees of the Curtis and Schley varieties growing under similar orchard conditions and noted the need for recognizing varietal differences in studies on leaf composition. Pecan varieties vary markedly in their bearing characteristics, and most orchards have varieties interplanted as a mixed population. In the light of the foregoing discussion, it would be expected that the bearing characteristics of the variety selected for sampling would be reflected in the data obtained from any given orchard and thus affect the appraisal made from analytical data obtained from leaf samples. The data shown in Table V indicate that this is true.

These data were obtained over a period of years from trees in several experiments with three varieties, Moore, Schley, and Stuart. Three soil series were involved, but some of the samples of each variety came from trees on the same series. The data should be considered as indicating a trend only and not as established facts, because different seasons were involved and it is known that there are pronounced variations in the composition of leaves from the same trees between seasons. The number of samples involved, however, lends weight to the importance of the trends indicated. All samples for each variety were taken in September, but the crop load on the trees varied materially from year to year as well as within a given year. The mean amounts of each element as well as the ranges are given in order to show the variations encountered.

These data indicate that the leaves of the Moore and Schley varieties may be expected to contain similar levels of nitrogen, but those of the Stuart variety may have a higher level. Phosphorus may be lowest in the leaves of the Moore variety, intermediate in the Schley, and highest in the Stuart. There was very little difference in the mean levels of potassium in the leaves of the Moore and Stuart varieties, but the mean level in the leaves of the Schley was considerably higher. There

TABLE V.—CHEMICAL COMPOSITION (DRY-WEIGHT BASIS) OF LEAVES FROM MOORE, SCHLEY, AND STUART PECAN TREES.

Variety	Samples	N		P		K		Ca		Mg	
		Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
	No.	%	%	%	%	%	%	%	%	%	%
Moore	525	2.12	1.71–2.42	0.111	0.079–.160	0.72	0.25–1.63	1.69	1.01–2.23	0.32	0.19–.54
Schley	120	2.12	1.76–2.42	.128	.100–.172	.94	.65–1.22	2.14	1.58–2.60	.24	.16–.32
Stuart	116	2.36	1.80–2.71	.139	.120–.176	.75	.54– .95	1.65	1.18–2.09	.35	.24–.49

was a much wider variation in the level of potassium in the leaves of the Moore variety than in those of the other two. The calcium level followed very closely the same trends as that of potassium, with the Schley variety having the highest level. The magnesium level was lowest in the leaves of the Schley variety, probably a reflection of the higher potassium and calcium level in this variety, which is a common occurrence in plants.

These data show that the varieties differ considerably in the proportion of the various elements found in the leaves; therefore, variety should be taken into consideration when sampling an orchard or an area for the purpose of appraising the fertility status of the soils involved.

Discussion

Throughout these studies, the dominating factor influencing the chemical composition of leaves was the crop load on the trees. Anyone sampling an orchard or an area for the purpose of appraising the nutrient status of the trees might easily obtain misleading data if he did not recognize the effects of this factor. This would apply especially to the potassium in the leaves which follows the production cycle to a much higher degree than any of the other elements determined. It reaches low levels in the leaves toward the end of the season when trees are supporting a heavy crop of nuts, but builds back up to normal levels during the following season when a light crop or no crop is borne. The evidence from leaf samples taken in September indicates that there is no relation between the potassium level in the leaves of trees during the light crop year and that in the leaves in the following heavy crop year.

Studies on the relation of nutrients in leaves and the oil in nut kernels revealed that with prolific varieties potassium was the key element concerned with high oil development (3).

Lack of proper balance between potassium and nitrogen and potassium and calcium plus magnesium resulted in low oil in kernels in a vast majority of the cases with the prolific Moore variety but not with the less prolific Schley and Stuart varieties. It should be pointed out that there is no practical method of thinning nuts on pecan trees; therefore, prolific varieties often set a very large number of nuts when the trees are vigorous. All evidence accumulated indicates that a method by which some of the nuts could be thinned from trees when they set heavy crops would go a long way toward solving the nutritional problems.

Pecan trees of a single variety also vary greatly in bearing characteristics. Sharpe and Gammon (5) found large tree-to-tree variations in the composition of leaves from trees in compact blocks of the same variety which had received similar treatments and appeared to be of uniform condition. Undoubtedly, some of this variation is due to soil variation, but since pecan trees appear to vary to a much higher degree than most other trees, it does not seem logical that all the variations encountered are due to the soil. The possible effects of two other factors appear to fit logically into the picture. The first of these is the heterogeneous seedling rootstocks on which the standard varieties are budded. Each seedling differs in some respects from all others. It is known that with other crop trees, the rootstock exerts an important influence on the leaf composition of the scion, and often determines whether success is attained in growing the crop in certain localities. It seems logical to assume that difference in rootstock in pecans is one important variable which is probably making it difficult to establish a reasonably accurate base for critical nutrient levels.

The other possible explanation for the variable performance of pecan trees is that they are subject to the influence of mycorrhizal fungi associations on their roots (7). It seems established that under certain soil conditions associations of such organisms play a role in the nutrition of young trees on the roots of which they become established (6). It was found that certain kinds of forest trees growing in association with mycorrhizas can absorb potassium and phosphorus from insoluble minerals. There is a possibility that this association may explain some of the wide fluctuations found in the levels of these two elements in pecan leaves and the low response to applications of these elements to the soil around the trees. Direct yield response to applications of potassium fertilizers has been especially difficult to establish. This is due in part to the fact that measured yield of pecan nuts in the shell is not a good criterion for measuring tree response because any treatment which causes an increase in the set of nuts beyond a certain number often results in nuts of small size with poorly developed kernels, and the potential yield of nuts, had they been of normal size and well filled, is not measured. Fertilizer treatments have increased the number of nuts on trees as much as 25% without affecting the yield because of the small size of the nuts and poor kernel development.

Summary

Leaf analysis was used in conjunction with field experiments with pecans involving fertilizer applications and cultural practices with the view of establishing critical levels of various essential elements which might be used as guides in surveying areas for potential nutrient deficiencies. Extremely variable results were obtained and some of the sources of these variations were identified.

The content of nutrient elements found in the leaves was influenced markedly by the crop condition of the trees sampled. Other factors influencing the levels of nutrients were the type of shoots sampled, the time of sampling, and the variety.

The potassium and phosphorus levels

in leaves were found to be related to the crop load on the trees to a higher degree than levels of other elements; both of these elements reached low levels toward the end of the season when heavy crops were supported by the trees.

Low levels of potassium in leaves by late season followed the production cycle as was shown by the low amounts in the leaves and the high correlations between years of heavy crops and the absence of such correlation in the "off-crop" years.

The balance of nutrient elements was notably different for the Moore, Schley, and Stuart varieties, indicating the need for sampling by variety. The difference in the composition of the leaves of the varieties appears to be related to their bearing characteristics.

It is concluded that anyone using leaf analysis to survey orchards for identification of probable nutrient deficiencies should consider the sources of variation described herein when taking samples; otherwise, misleading data might be obtained.

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BUILDING ANNUAL YIELDS . . . AND LAND VALUE

THE use of fertilizer not only improves the immediate crop but the unused surpluses of plant nutrients continue to increase succeeding crop yields. Thus, a good application of fertilizer for corn or tobacco will not only pay dividends for those crops but will go far in producing high yields of wheat, barley, hay, or pasture. Indeed, the full cost of the fertilizer application should not be charged to the immediate crop.

Continued increase in fertility and production capacity resulting from efficient fertilizer use increases land values and assets. In the past, there was a general tendency to "wear out" land and turn it over to succeeding generations in a depleted condition. Now this practice is changing and each generation is more and more interested in building the productive capacity of the land. Thus, as a farmer, through his lifetime, increases the productivity of his land, he also increases the value of his farm and his estate.

Kentucky Bankers Association

NEW ERA . . .

A new era is beginning in research work on soil compaction and hardpans —physical conditions that often reduce crop yields.

These compacted soil layers may be "induced"—as by tractor and implement traffic over cultivated land, or "genetic"—through development of the soil itself.

Spurred by growing concern with the problem, USDA and cooperating agencies around the country have launched a broad program of experimental work in varying soils, conditions, treatments, and implements.

The move recognizes that physical properties of soil have become a more limiting factor to production with the increased use of new fertilizer practices, new insecticides, new crop varieties, irrigation, drainage, and other means of increasing output. It also recognizes that the problem is growing steadily as traffic increases over cultivated land through mechanized farming and more cultivation. Further, the move takes note of the fact that many farmers now have at hand the heavy power and tillage machines to do something about the problem.

Research also is now in a position to do something about the problem, thanks to several important advances. One is the recent development by a New Jersey soil physicist of a "densitometer," which uses gamma ray absorption for quick, accurate measurement of soil density. Another step is the work of a joint committee that has been set up by the American Society of Agricultural Engineers and the Soil Science Society of America to define terminology used in soil-compaction studies. Then, too, teams of agronomists, engineers, and soil physicists have been organized to work together on this problem.

These developments are removing roadblocks that once stymied the progress of soil-compaction research.

Core-sampling, for example, is laborious, and reliable measurements are hard to get in certain soil conditions. Tests with the new densitometer take little time and effort and can be made as often as necessary to follow the change in soil conditions after treatment.

The joint committee's efforts in clarifying terminology should help in the interchange of research results among the different workers involved in this problem.

Teamwork by the scientists will make possible far more detailed studies of soil compaction and a closer evaluation of relationships between soil chemistry and physics, management, productivity, and tillage operations.

HIGH TIME . . . TO USE WANT-CREATING IDEAS

"What do consumers want in agricultural products? They want quantity, quality, good nutrition, and attractive price. But they also want variety, convenience, eye-appeal, and taste-appeal. It's high time that agriculture used more of the legitimate want-creating techniques employed so successfully by other segments of the economy. Americans throughout the land know about the 'pause that refreshes'—television viewers can tell you the beverage that made Milwaukee famous—and TV fight fans know the answer to the query, 'What'll you have?' But they don't think about a delightfully refreshing cool glass of milk when they hear it."

Ezra Taft Benson

HITS SOIL COMPACTION

At the ARS Tillage Laboratory at Auburn, Ala., the mechanics of soil disturbance will be studied. The laboratory is well-equipped to test commercial tillage machines, improve them, and develop others. Much research can be done at Auburn with small scale model machines in a special laboratory that's set up for testing and evaluating the machines under known conditions.

It has been known for years that compacted soils inhibit plant root growth and moisture penetration. Early efforts to relieve these conditions led to the conclusion that sub-soiling yields little worth-while results.

More recent studies show that deep-tillage treatments that shatter induced pans or compacted layers may increase crop yields in certain years, but the benefit may last only a single season. Deep tillage alone hasn't been very successful on claypan soils. Deep tillage, plus deep placement of lime and fertilizer, may be beneficial, but its advantage over placing lime and fertilizer in the normal plow layer is in question. Compaction research thus far doesn't justify any generalization on the effects of deep tillage on many different soils.

Through Federal-State cooperation, it's possible to coordinate studies and handle problems according to soil and agricultural areas. The scientific-team approach and new techniques and equipment will help.

When all these forces are brought to bear, we may expect answers to many important questions:

(1) What soil conditions respond to deep-tillage operations? (2) How long does the effect of such treatments last? (3) Should amendments, such as lime and fertilizer, be placed in the fractured zone? (4) How can amendments best be placed? (5) Should rotations be established to provide an occasional sequence of deep-rooted legumes to penetrate and help hold open the fractured soil horizons? (6) What chemical and physical factors that limit plant growth on different soil types may be effectively treated? (7) What types and designs of equipment are best suited to give maximum physical results? (8) Can the development of compacted layers be prevented by the use of deep-rooted crops, or by eliminating certain tillage operations?

Agricultural Research Service—USDA

HUMAN BEING CONSUMES TONS IN A LIFETIME

In his life a human being consumes a tremendous amount of food. In 70 years he eats 1,400 times his body weight—over 200,000 pounds of material.

The amount of food that he will take includes 6,000 loaves of bread, 3 oxen, 4 calves, 4 hogs, 4 sheep, and 300 chickens. The amount of fish taken will include 2,000 large fish, 3,000 sardines, flounders, and herring.

He will eat about 9,000 pounds of potatoes; 12,000 pounds of other vegetables; 14,000 pounds of fruit, and 6,000 quarts of milk. He will take in also 12,000 quarts of coffee; 1,000 pounds of salt; 5,000 eggs; 8,000 pounds of sugar; 2,000 pounds of cheese; 10,000 quarts of water; and a lot of smaller delicacies.

Youth Today

AGRICULTURE, THE G

In the lobby of the Department of Commerce Building in Washington, there is a large electronic board flashing lights on and off every few seconds tallying America's population growth by the minute.

Every 8 seconds a light flashes on indicating a birth, every 21 seconds indicating a death, every 2 minutes indicating an incoming immigrant, every 24 minutes indicating an outgoing emigrant.

When the tally is averaged up, the *net growth* of our population is five human beings each minute, 300 each hour, 7,200 each day.

With its population increasing by 7,200 citizens a day, the United States is predicted to have well over 200 million mouths to feed by 1975. And, equally interesting, Canada with over 16 million population today is predicted to have nearly 27 million mouths to feed by 1975.

That's just 18 years away, about the time the 10,921 babies born in both the United States and Canada today will be ready for college.

Who's going to feed these 230 million mouths—or produce raw materials for most of their clothes and shelter?

With this issue, *Better Crops* begins a series of editorials we choose to call "Agriculture, The Great Adventure." The purpose of the series is:

1—To spotlight the creeping decline of agricultural students enrolled in agricultural colleges.

2—To present the profession of agriculture for what it is—one of the most interesting, most versatile, most rewarding professions in the world today.

3—To urge more farm youth to pursue their heritage.

In modern America, we believe, agriculture is the finest profession a young man or woman can enter in these times. We believe this because it offers such versatile opportunities.

No longer is the agriculturalist a farmer alone—struggling with the four-foot plow, the splintery hoe, the rusting water bucket, and the

Oh, for the Life

• What a snap. All he has to know is enough to be:

• A combination engineer-blacksmith-inventor who keeps $15,000 worth of intricate farm and home machinery in top working order.

• A meteorologist who assembles and evaluates weather reports, signs, and omens with enough accuracy to assure his family of a livelihood.

• A veterinarian who sits up all night nursing a bunch of sick pigs, attending a cow, cradling a sick horse's head, spoonfeeding young turkeys with the croup.

• A lumberjack who's a foreman, sawyer, and carpenter all in one.

REAT ADVENTURE—I

kerosene lamp. Today he must be a businessman, an agronomist, a veterinarian, something of a mechanic, a scientist, an economist, a technically talented human being—using the four-row planter, modern plant food, the corn harvester, chemical weed control, and modern home utilities with skill and success.

It is hard to believe but it is true that over 500 different occupations are now available in the agricultural field, according to the National Association of Land-Grant Colleges and Universities. If we digest them into 8 basic fields, they include research, industry, finances, education, communications, conservation, special services, and farming and ranching. They could employ 15,000 new college graduates this year. But with the land-grant colleges graduating around 8,500 a year among them, that makes about two futures for each graduate.

Many areas today urgently need college-trained people to farm their own land, well-schooled technologists in the fertilizer, dairying, feed, insecticides, farm implements, and distributing industries. They put agricultural graduates into key positions and call for more. The opportunities are there, if our youth will seek them.

In the second editorial of this series, we shall look at the field of agricultural industries—its opportunities and its future for the farm youth of the nation. Until then, we invite every student who reads this to think again before he rejects the idea of entering some phase of agriculture for a lifetime career.

To do this intelligently, of course, he must secure reliable information upon which to think. Every land-grant college in the nation, the United States Department of Agriculture, the various State Departments of Agriculture, all, gladly provide facts and figures showing what fine opportunities await young people choosing agriculture as a career.

ife of a Farmer

• A chemist who knows the ingredients with which to feed his soil, kill the bugs, dip the sheep, and clean the stable.

• A financial genius who figures out for Uncle Sam the tax he's going to pay on chicks which aren't hatched, corn that's still seed, and wheat still in the field.

• A livestock market expert who knows exactly when to sell what and to whom.

• A jack-of-all trades and a master-of-all, too.

• And a man who not only feeds his own family, his own nation, but over half the world. . . .

Oh, for the life of a farmer!

Paul Light

Thorn in the Soilman's Flesh

The soybean is a major crop in American life today—a billion dollar crop, in fact.

It occupies 22 million acres of American crop land. It is the most important cash crop in several Midwest states, the fifth most important farm crop in the nation. With its growing importance, demands for information on how to increase its yield continue to mount. Yet, so far, we know little about fertilizing soybeans on soils of average fertility—a thorn in the sides of agronomists ever since the crop became important in the agricultural economy.

At the seventh annual meeting of the National Soybean Crop Improvement Council, several interesting conclusions were reached on the problem of soybean fertility:

- In the Corn Belt, soybeans are the only crop that has not responded consistently to the various rates, placements, combinations, ratios, and grades of fertilizers directly applied in a manner and at levels which would make it as economical to fertilize them as the other crops commonly occurring in the same rotations.

- The response of soybeans to fertilizer is highly variable in the Midwest on different soil types and on different productivity levels of the same soil type.

- It has been only on low fertility soils deficient in one or more nutrients that the addition of the deficient element or elements has increased yields 8 to 12 bushels per acre.

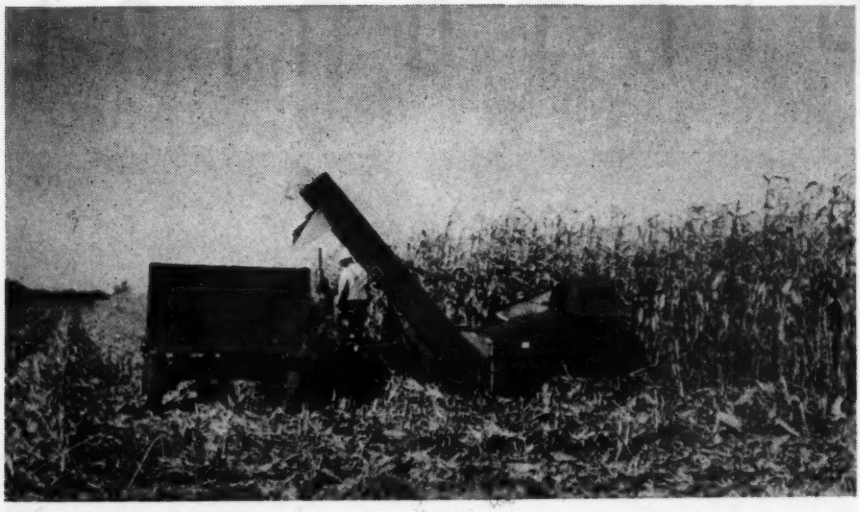
- The *modern practice* of supplying large enough amounts of fertilizer to provide the quantity of nutrients necessary for optimum crop yields—eliminating *fertility* as a factor in crop production along with *improved varieties, better equipment,* and *cultural practices*—has been a key factor in many cases of increased soybean yields.

- But soybeans have generally responded less to both increased fertility and to individual nutrients than have other crops. Apparently there must be some plant-soil relationship of soybeans that is not yet understood.

- Results so far on soybean fertility emphasize the need for much additional information. Fifty bushels and even above 60 bushel yields are sometimes obtained, but to pin-point the factors that produce these yields and thus tell other growers how to go and do likewise has escaped research men to date. The average grower still wants to know how to break through his apparent barrier of 35 to 40 bushels per acre.

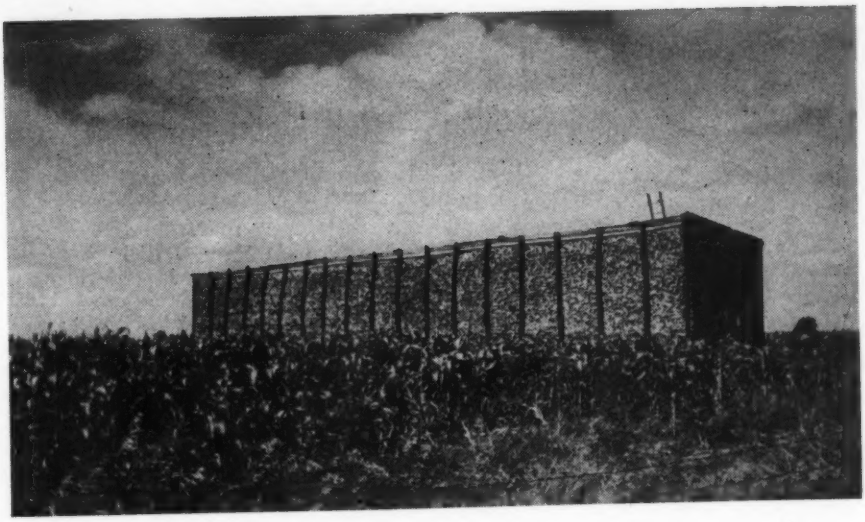
PICTORIAL

The grass is always greener . . .



Modern machinery lightens the work . . .

While efficient plant foods . . .



. . . of harvesting and storing record corn crops

. . . help produce quality yields

Out of this midwest soil millions of soybeans grow . . .

. . . to go to mills that extract their oil by the tons

The Editors Talk

OF COBS AND CORN

The lowly corncob is coming into its own—at last. Nearly 1 million tons of them were used last year, in contrast to only 5,000 tons as recently as 1939.

Thousands of tons a year now serve as a source of furfural—an oily, straw-colored liquid, valuable in defense and other industries for refining vegetable and petroleum oils, for producing synthetic rubber, nylon, synthetic resins, and medicinals.

The next largest consumers of corncobs are the metal-stamping and electroplating industries, which find cob products superior to the hardwood sawdust previously used in those fields. Ground cobs are used to remove spots and dirt, to polish metal stampings, to help absorb residual plating solutions from electroplated parts and to polish them.

Thousands of tons are used annually as livestock bedding and poultry litter, while ground cobs are used by many gardeners and nurserymen as a mulch. Combined with blackstrap molasses and other nutrients, they are widely used for beef cattle feed. Cob meal is replacing corn meal as a mild abrasive in hand soap, while fine cob flour is used in producing insecticides.

They are, also, used as a cork substitute; as a meal for cleaning furs, burnishing metals; as a dynamite filler or absorber; as a fuel and kindling; as insulation and packing material; as plastics filler; as a polishing agent; as a solvent and decolorizer—and, of course, as bowls for pipes usually smoked by man-size smokers.

Though it has taken some giant strides up the ladder of industrial society in recent years, we figure it will be a long time before the cob is worth more than the corn.

But, we still tip our hat to the lowly corncob—once just the butt of hayseed jokes told on the hind side of the furtherest barn, now a coming resource in the life of modern industries.

Fig. 1. Cattle grazing white clover in March on a white clover-Pangolagrass pasture growing on Rex fine sand.

FERTILIZING

Pangolagrass

and

White Clover

ON REX FINE SAND

THREE experiments were conducted near Gainesville on Rex fine sand to study the utilization of nitrogen, phosphorus, and potassium by white clover-Pangolagrass and Pangolagrass pastures. This soil occurs on rolling to nearly level relief in northern Florida and is moderately well to somewhat poorly drained. The surface soil contains about two per cent organic matter.

In all of the experiments phosphorus was applied as single strength superphosphate and potassium as muriate of potash. In the experiment where white clover was grown, sufficient high calcium lime was applied to maintain the reaction of the surface six inches of soil at pH 6.0 or slightly higher. Where Pangolagrass was grown alone, lime was applied to maintain a pH of 5.5.

Experiment 1 was used to determine

Fig. 2. Cattle grazing Pangolagrass in August on a white clover-Pangolagrass pasture growing on Rex fine sand.

By William G. Blue and Nathan Gammon, Jr. • Soils Department

Florida Agricultural Experiment Station • Gainesville

the quantities of phosphate and potash necessary for maximum yields of white clover in a white clover-Pangolagrass pasture. Nine treatments were used in a randomized block design with four replications. Three rates of phosphate varying from 20 to 180 pounds per acre and three rates of potash, 60, 120, and 180 pounds per acre, were used to give 1:1, 1:2, and 1:3 ratios of phosphate to potash.

Treatments involving the lowest potash rate were made in October. Those with the intermediate rate were made in split application, one half in October and one half in January or February before the first harvest of clover. The highest potash treatments were also made in split application, one third in October, one third in January or February, and one third in March following the first harvest of clover.

Experiment 2 was set up to determine the rates of nitrogen and of phosphate-potash fertilizer needed for maximum yields from white clover-Pangolagrass pasture. Three rates of nitrogen and three rates of fertilizer containing phosphate and potash were used. Ammonium nitrate and sodium nitrate were used as sources of nitrogen.

Experiment 3 was similar to experiment 2. However, Pangolagrass was grown alone and slightly more nitrogen was applied because of the absence of clover.

The nitrogen was applied periodically throughout the season at differential rates. The first increment for the clover-grass experiment was applied in May after the last clover harvest; subsequent applications were made after each grass forage harvest. For the Pangolagrass, the first application

was made in March and subsequent applications were made after each harvest during the remainder of the summer.

These experiments were conducted by a clipping-grazing technique which was an attempt to approximate actual grazing conditions. The purpose was to avoid excessive removal of plant nutrients which results from mowing and the removal of forage from an area. Yields and forage samples for analysis were obtained by clipping a portion of each plot. The forage was then spread back on the clipped areas after which all plots were grazed simultaneously. There was usually a lapse of one week between clipping and grazing, and refertilization.

Results and Discussion

Yield data from Experiment 1 (Table I) showed a significant yield increase for phosphorus through the 40 pounds per acre rate. There was some yield response above 40 pounds, but it was inconsistent and nonsignificant. Sixty pounds of potash appeared to have been nearly adequate since yields were not significantly increased by higher rates. However, slightly higher yields were consistently produced by 120 or 180 pounds of potash which may indicate need for additional potash for maximum yields.

Data from Experiment 2 (Table II)

TABLE I.—AVERAGE YIELDS OF WHITE CLOVER FORAGE PRODUCED IN 1953, 1954, AND 1955 AND AVERAGE YIELDS FOR THE THREE YEARS FROM EXPERIMENT 1.

Treatments P_2O_5–K_2O	Oven-dry forage			
	1953	1954	1955	3-year averages
	(Pounds per acre)			
20– 60	1490	1390	1180	1320
30– 60	1110	1490	1280	1290
60– 60	1820	2000	2260	2030
40–120	2210	2450	2240	2300
60–120	1950	2260	2380	2200
120–120	2260	2640	2520	2470
60–180	2040	2480	2070	2200
90–180	1490	2540	2310	2110
180–180	1740	3160	2770	2560
LSD .01	740	1130	760	770
LSD .05	540	830	550	570

TABLE II.—YIELDS OF OVEN-DRY WHITE CLOVER AND PANGOLAGRASS FORAGE RESULTING FROM DIFFERENTIAL NITROGEN TREATMENT FROM EXPERIMENT 2.

Nitrogen applied pounds per acre	Yield in pounds per acre		
	1952	1954	1955
	White Clover (Harvested approximately April 10)		
None	950	760	770
None	1260	640	950
None	850	940	830
	(Harvested approximately May 5)		
None	400	510	.....
None	510	590	.....
None	500	620	.....
	Pangolagrass (Harvested approximately July 15)		
24	2140	1890	2120
48	2280	2800	2480
72	2850	3240	1840
	(Harvested approximately August 25)		
48	1630	1060	2870
96	2440	1660	3440
144	2460	1700	3130
	(Harvested approximately October 10)		
72	690	2310	5060
144	900	4020	6210
216	1130	4260	6010
	Total yields		
72	5810	6530	10500
144	7380	9140	13080
216	7790	10760	11810

show that 80 pounds of potash per acre in a 1:2 phosphate-potash ratio were adequate for maximum yields of clover. Three rates of potash, 80, 160, and 240 pounds per acre in a 1:2 phosphate-potash ratio, were used. No significant increase in clover yields was obtained for these treatments. This quantity of potash also gave maximum yields of grass.

Using forage yields as the criterion, it may be concluded that approximately 40 pounds of phosphate and 80 pounds of potash per acre per year were adequate for maximum yields of white clover. Plant analytical data substantiate these conclusions. Plant phosphorus increased through the 40-pound rate of application. Plant potash was significantly increased by 120 or 180 pounds of applied potash per acre over the 60-pound application. The fact that plant potash concentrations for the 60-pound rate of application were in the deficient range at the second harvest, and that concentrations of potash were increased by the 120-pound rate lends credence to the conclusion drawn from the yield data that somewhat more potash was needed than was furnished by the 60-pound per acre rate.

Yield increases from increasing rates of nitrogen in Experiment 2 (Table II) and Experiment 3 (Table III) were relatively uniform in 1952. The percentage of nitrogen in the forage generally increased with each rate of nitrogen.

During the winter of 1952-53 the stand of Pangolagrass was seriously depleted and no data are available for 1953. The grass was replanted that summer. Numerous observations indicate that stands of Pangolagrass may be severely reduced by winter injury under high rates of nitrogen fertilization in northern Florida.

For 1954, yield increases between each rate of nitrogen were approximately the same, and plant nitrogen also increased. No yield response to nitrogen was obtained in 1955 above the minimum rate of 96 pounds of nitrogen per acre. However, yields were as high as had been obtained in previous years at the highest rate of nitrogen used. The nitrogen content of the forage was increased with increasing nitrogen rates. The lack of response was attributed, in part at least, to carry-over nitrogen and to low leaching as a result of relatively low rainfalls in 1954 and 1955.

The economic utilization of forage produced under intensive systems in

TABLE III.—RATES OF NITROGEN APPLIED AND YIELDS OF OVEN-DRY PANGOLAGRASS FROM EXPERIMENT 3.

Nitrogen applied pounds per acre	Yield in pounds per acre		
	1952	1954	1955
	(Harvested approximately May 1)		
24	710	1180	590
48	1200	810	300
72	1960	1470	320
	(Harvested approximately July 15)		
48	1340	1330	2010
96	1870	1960	1930
144	2440	2720	2050
	(Harvested approximately August 25)		
72	1150	840	2890
144	1500	1150	2810
216	1990	1650	2890
	(Harvested approximately October 10)		
96	430	2070	4620
192	430	3230	5330
288	520	4080	5550
	Total yield		
96	3640	5420	10060
192	5010	7160	10350
288	6910	9920	10830

Yields from plots receiving no nitrogen were approximately 2000 pounds per year.

northern Florida necessitates very strict management practices. Though large amounts of forage can be produced, the bulk of production occurs between April and October, and with the comparatively warm season grasses used in permanent pastures, the season of production is quite independent of the rate of fertilization. Clover, which is valuable for several reasons, lengthens forage production at a critical period, but its direct contribution to total forage production, with heavy fertilization, is usually small.

Factors which must be considered for the economic utilization of forage in an intensive fertilization program are: (1) the rate of fertilization and portion of total pasture area to be fertilized; (2) the amount of forage which can be stored; and (3) the anticipated production of clover and interim crops, particularly winter-grazing crops, for grazing during periods of low production from permanent pastures. The production of forage is relatively expensive and without efficient utilization may be unprofitable.

Summary

On the basis of three years' data it appears that per acre applications of approximately 40 pounds of phosphate applied as 20 per cent superphosphate and 80 pounds of potash (400 pounds of 0-10-20) are sufficient for maximum yields of white clover in a Pangolagrass sod. These amounts were sufficient for maximum yields of Pangolagrass grown alone or with clover even when fertilized with as much as 288 pounds of nitrogen per acre.

A linear response of Pangolagrass to nitrogen, at all levels used, was obtained in 1952 and 1954. No response above 96 pounds of nitrogen per acre was obtained in 1955.

The season of grass forage production was not appreciably altered by rates of fertilization. ◄◄◄

IN ECONOMIC TERMS...A CAPITAL INVESTMENT

A WELL-PLANNED fertilizing program means a saving in labor costs, according to H. J. Mederski, an Agronomist at the Ohio Agricultural Experiment Station. He suggested three ways to achieve this goal. Use high analysis fertilizer wherever possible; use bulk spreaders; and shift the emphasis from row applications to the more convenient use on sod crops or other suitable places in crop sequence.

"In economic terms, fertility build-up is a capital investment," Mederski declared. "A maintenance application is actually an operating cost."

The agronomist said it's possible in some cases to operate a farm on a strictly maintenance basis, but a better method is to raise the nutrient level of the soil to a point where crop production is efficient and then maintain it at or near that level. Farmers will have to decide for themselves how to set up an effective fertilizing program. Much depends on the magnitude of the job and the financial status of the individual farmer.

Mederski's plan calls for increased use of fertilizer in summer and fall and less in the spring when a farmer's time is at a premium. This may mean cutting row fertilization down to about 150 pounds an acre and increasing the amount of plant food that goes to build up general fertility. In this way, farmers can help eliminate fertility as a limiting factor in crop production.

FOR PLANT RESEARCH

New York City has dedicated a laboratory for study of plants. It is located at the N. Y. Botanical Garden. The million-dollar unit has 32 research rooms, with equipment to control humidity, light and temperatures.

Studies will be conducted in plant nutrition, propagation, abnormal growth, diseases, antibiotics and antiviral substances associated with plants. Projects are scheduled to inquire whether compost piles are sources of plant diseases and insects, and whether natural gas injures vegetation.

"There are still areas where our ignorance is profound and many questions for which we have no answers," Dr. William J. Robbins, director, said at the dedication. He hoped that "by combining the skills of the chemist with those of the biologist in attacking mysteries of plant life," important discoveries may be made.

WHEEL-TRACK PLANTING

Easier corn production and better soil conservation at the same time—that's the advantage of a new corn-growing system outlined by two University of Wisconsin scientists.

A. E. Peterson and A. M. Strommen spoke before the Agricultural section of the American Association for the Advancement of Science, reporting research with wheel-track corn planting and alfalfa interseeding.

With wheel-track planting, the farmer merely plows the ground, then drives back over the land with a corn planter dropping seeds in tracks left by the tractor tires. Thus, he has to travel over his land only twice.

Under the conventional system of corn planting, the land is worked with a disc or harrow several times between plowing and planting. This not only takes additional time during a busy season, Peterson and Strommen explained; it also gives weeds a chance to get a head start and it breaks down the structure of the soil.

Since the land between corn rows is left in a rough condition by the wheel-track method, it's less likely to wash away in spring rains; each furrow acts as a dam to hold back the water.

Yields of wheel-track-planted corn have equaled yields of conventionally planted corn in the Wisconsin tests—sometimes as high as 130 bushels per acre.

FOR EMERGENCY PASTURE

SUDAN grass is the best emergency pasture for Ohio farmers who have seeding failures, Earl Jones, Ohio State University Extension Agronomist, says. Sudan makes faster growth and more high-quality feed than other emergency forage crops.

Farmers can seed Sudan grass until June 10 for summer and early fall pasture, for silage, or for hay. Most farmers seed 20 to 30 pounds of Sudan per acre from the wheat side of their grain drills with drills set to sow 2 pecks per acre.

Recommended varieties for Ohio are Piper, Sweet, and Tift. Piper is best, according to Jones.

He recommends 300 to 400 pounds of 5-10-10 or similiar grade fertilizer per acre for all seedings. On less productive land he suggests adding 60-80 pounds of nitrogen before seeding, in addition to the regular fertilizer treatment. That would take 300 to 400 pounds of a 20 per cent nitrogen fertilizer.

As a precaution against cyanide poisoning, farmers should wait until the Sudan grass is 12-15 inches high before pasturing it.

SOIL TESTING VIA COUNTY LABORATORIES

A Four-Year Summary Showing Some Trends in Tests and Differences in Soil Regions of Kentucky

By William A. Seay and George D. Corder

Department of Agronomy • University of Kentucky

SOIL testing in Kentucky is done in county laboratories. Kentucky probably has more county soil-testing laboratories (107 in September 1956) than any other state. The first county laboratory was established in 1948 and the number increased rapidly. Since 1951, reports have been compiled from these laboratories and sufficient data are now available to note some trends in tests and differences in soil regions. This paper reports data for the period 1952 through 1955. The authors wish to give credit to the county agents who compiled and forwarded county data which have made this study and report possible.

Test Methods

Samples are tested for soil acidity, available phosphorus, and available potassium. Each sample is accompanied by an information sheet. The importance of this information has been noted by the senior author (Better Crops XXXIX, No. 10:19-22, 45-46 December 1955).

Soil acidity is determined by measuring pH with a glass electrode pH meter in a few of the larger county laboratories, but most laboratories measure the pH of a 1:4 soil water decantate with Benzo Red indicator by comparing with a standard color slide. Soil acidity is divided into four ranges: strongly acid (below pH 5.3); moderately acid (5.3—6.0); slightly acid (6.1—6.7); not acid (above pH 6.7).

Available phosphorus is determined by extracting with 1:4 soil extractant ratio of 0.15N sulfuric acid for two minutes. The blue color developed by stannous chloride is read on a standard color comparator to give pounds of available phosphorus per acre. Available phosphorus results are divided into five groups: very low (below 10 lbs.

[1] Published with the permission of the Director of the Kentucky Agricultural Experiment Station and Extension Service, Lexington, Kentucky.

per acre); low (11-25); medium (26-50); high (51-100); very high (above 100 lbs per acre).

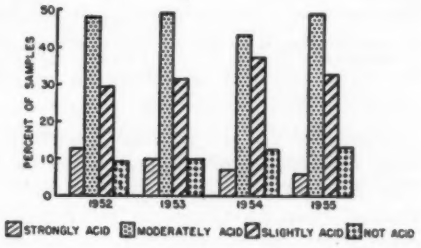
Available potassium is partially based on the Purdue test. A sodium cobaltinitrite-sodium nitrite-acetic acid extracting solution (pH 5.0) is used. The soil solution (ratio of 1:2) is shaken vigorously for one minute and turbidity developed in the filtrate with isopropyl alcohol. The Central Laboratory determines potassium in the same extract as used for phosphorus. Results from either potassium method are recorded as: very low (below 80 lbs. per acre); low (80-125); medium (126-200); high (201-300); very high (above 300).

The Central Laboratory in the Experiment Station, Lexington, serves as a check for all the county laboratories. County agents periodically send soil samples along with the results from tests conducted in their county laboratories to the Central Laboratory for checking. This gives the county agent assurance that his laboratory is operating efficiently or that trouble will be diagnosed early should it develop. Also, the Central Laboratory supplies county laboratories with standard soil samples which are tested at regular intervals by the county soil technician as a check on his reagents, glassware, and procedure.

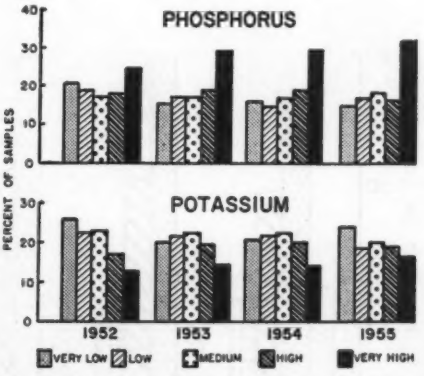
Trends During 1952-1955

The number of samples reported tested annually in Kentucky increased from 36,929 in 1952 to 59,582 in 1954. In 1955 the number dropped to 44,520. Fig. 1 shows some change in the proportion of samples in the four soil acidity groups during the four years. Although nearly 50% of the samples tested moderately acid or below (pH 5.3-6.0), the proportion of strongly acid (below pH 5.3) samples has consistently decreased.

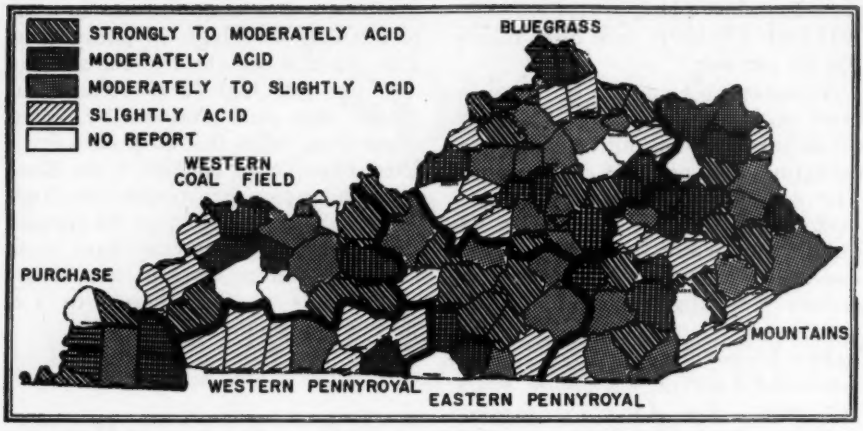
Fig. 2 indicates practically no change in the proportion of samples in each potassium and phosphorus category during the four years except that there has been a consistent increase in samples testing very high in phosphorus. The fact that one third of the samples now test very high in phosphorus indicates that most samples are being taken from fields that have been fertilized. However, much land in the Bluegrass soil region is naturally very high in phosphorus. As 38% of the samples during the past four years have come from this soil region, this also causes a skewness in the phosphorus frequency distribution of the State.



1. Classification according to soil acidity of all samples tested in Kentucky in the years indicated. Average annual number of samples was about 45,000.

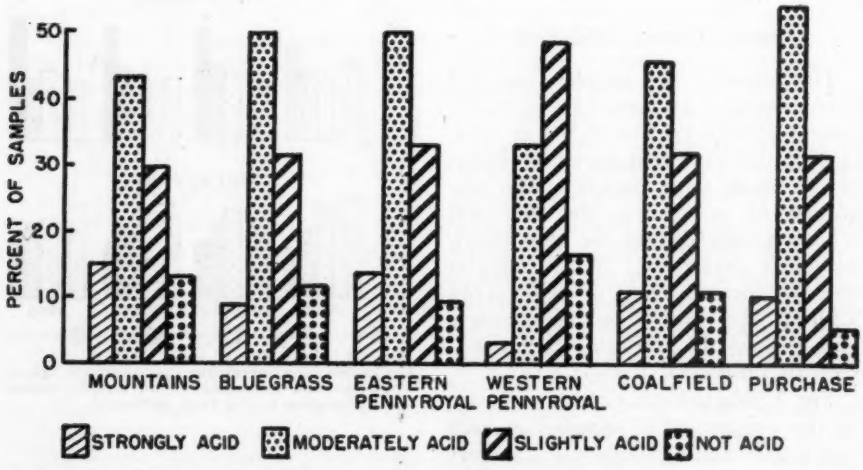


2. Classification according to available phosphorus and potassium of all samples tested in Kentucky in the years indicated.



3. Classification according to soil acidity of samples tested in each soil region for the period 1952-55.

Kentucky can be divided generally into six broad soil regions (Fig. 3). The *Bluegrass* region consists of soils derived from limestones in the rolling central part to interbedded calcareous shales, limestones, and siltstones in the hilly part. Some of the soils are naturally very high in phosphorus and crops do not respond to phosphorus fertilizer. The *Mountains* are very steep and farming is principally confined to the narrow bottom lands, some of which are quite fertile. Cultivated crops are limited to less than 10% of the area. The *Eastern Pennyroyal* is rolling, hilly, and karstic in places. The soils are from impure limestones and are of fair value for general farming. The *Western Pennyroyal* soils are from limestone and loess residuum. The land is undulating and well suited to cultivation, responding well to lime and fertilizer. The *Western Coalfield* is made up of a mixture of bottom lands along the Green and Ohio Rivers and the bordering hilly uplands derived from acid siltstones, sandstones, and shales. Loess influences most of



4. Distribution of counties according to soil acidity groupings in 1954.

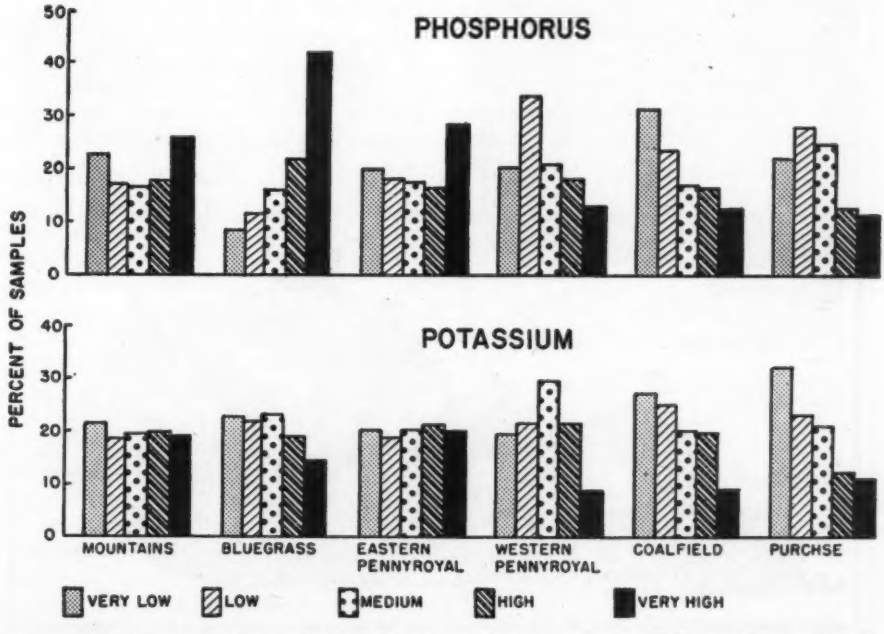
the soils. The better-drained bottom soils are very fertile and make up "Kentucky's Corn Belt," but much of the area is acid and infertile. The *Purchase* soils are derived from loess underlain by sands and gravels. The terrain is undulating to rolling, erodes easily, but responds well to good management, lime, and fertilizer.

Fig. 4 shows the distribution by soil region of samples according to soil acidity. This frequency distribution is for the period 1952-55. At least half of the samples in all regions except the Western Pennyroyal test moderately acid or below. The soil acidity distribution among the regions is nearly the same except for the Western Pennyroyal which has a larger proportion of slightly acid and non-acid samples and a smaller fraction of strongly and moderately acid samples.

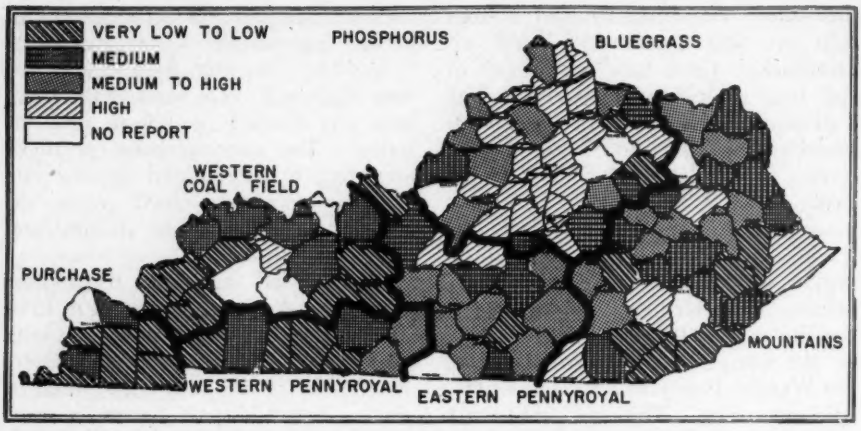
In order to arrive at a single index to represent the "average" status of soil acidity and/or available nutrients in each county, a weighted average method [2] was used. The percentage of very low samples was multiplied by 1, low by 2, medium by 3, high by 4, very high by 5. The sum of the products was divided by 100 to give the index. The counties were arranged according to indices and divided into approximately four equal groups depending on gaps in the indices near the dividing points.

Fig. 3 shows the county distribution of soil acidity of samples taken in 1954. There seems to be little correlation with soil region except that the Western Pennyroyal is less acid than other regions. Soil acidity in Kentucky counties is probably related to limestone usage. State PMA estimates of lime used in 1954—the trends are similar for earlier years—show that counties with samples testing strongly to moderately acid used an average of 6,800 tons of lime; counties testing moder-

[2] Parker, F. W., W. L. Nelson, Eric Winters, and I. E. Miles. The broad interpretation and application of soil test information. Agronomy Journal 43:105-112. 1951.



5. Classification according to available phosphorus and potassium of samples tested in each soil region for the period 1952-55.

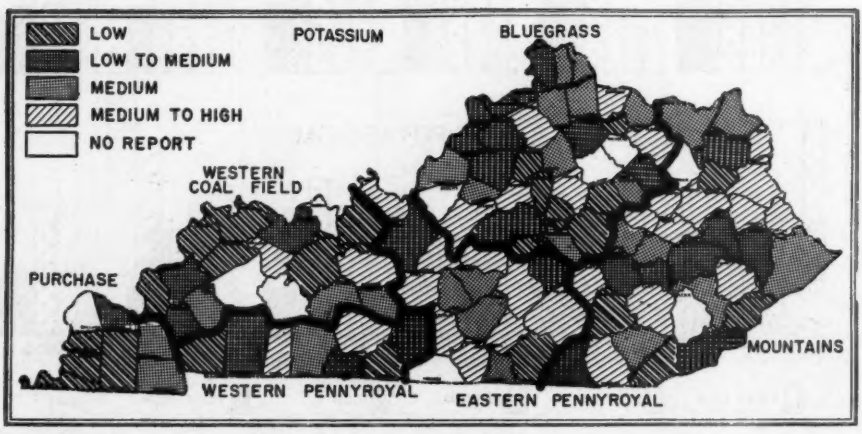


6. Distribution of counties according to available phosphorus groupings in 1954.

ately acid used 7,200 tons; those testing moderately to slightly acid, 8,000 tons; and those testing slightly acid, 9,500 tons. More than one third of the state's limestone quarries are located in the slightly acid counties. Each county in the Western Pennyroyal has one or two limestone quarries except the one most acid county. The Purchase which has the lowest, most acid, index of any soil region has no limestone quarries.

Fig. 5 shows the distribution by soil regions of samples according to available phosphorus and potassium for the years 1952-55. The Bluegrass samples test decidely higher in phosphorus than in other regions. Many soils in the Bluegrass are derived from phosphatic limestone and are natively so high in available phosphorus that field crops do not respond to phosphorus fertilizer. The distribution of samples in the Coalfield is the exact reverse of the Bluegrass. More Coalfield samples fall in the very low phosphorus category. More than one half of the samples in the Purchase, Coalfield, and Western Pennyroyal test very low or low.

Fig. 6 shows the county distribution by indices of available phosphorus of samples in 1954. The Bluegrass and Eastern Pennyroyal are decidedly higher in phosphorus than the other regions.



7. Distribution of counties according to available potassium groupings in 1954.

The samples from the Purchase, Coalfield, and, to a certain extent, the Western Pennyroyal tested lower (Fig. 5) in potassium during 1952-55 than in the other soil regions. Fig. 7 which indicates the tests in 1954 does not show any consistent trends except Purchase may be lower than other areas.

About two thirds of Kentucky's tobacco is grown in the Bluegrass and Eastern Pennyroyal. More samples are tested for tobacco fields than for any other crop and it has been the practice for farmers to use the same field for tobacco. In this way the fertility is built up. This is noticeable to a lesser extent for potassium (Figs. 5 and 7) than phosphorus. With leaching and high removal by crops, potassium fertility cannot be built up like phosphorus.

In the Purchase, Coalfield, and Western Pennyroyal more samples are tested for general crops, and the fertility status has not been built up as much in these fields as in tobacco fields. Due to the fact that such a small proportion of Mountain soils is suitable for cultivation, it is most likely that fields being tested in this region have been fertilized. This probably accounts for more samples testing very high in phosphorus (Fig. 5).

The Department of Feed and Fertilizer of the Kentucky Agricultural Experiment Station is the official fertilizer control agency for Kentucky. Beginning in 1954, this department began to report fertilizer sales by grade in each county. Sufficient time has not yet passed to ascertain how much correlation exists between county soil tests and grade of fertilizer purchased. As both soil testing and fertilizer sales are reported on a county basis, this information will aid county agents, soils extension specialists, and industry.

Since this survey includes the soil-testing period 1952-55—when most samples in the past have been tested—results picture soil fertility in Kentucky at the beginning of soil testing.

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Available Phosphorus	Magnesium
Chlorides	Aluminum
Sulfates	Replaceable Calcium

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Season Average Prices Received by Farmers for Specified Commodities *

Crop Year	Cotton Cents per lb. Aug.-July	Tobacco Cents per lb.	Potatoes Cents per bu. July-June	Sweet Potatoes Cents per bu. July-June	Corn Cents per bu. Oct.-Sept.	Wheat Cents per bu. July-June	Hay [1] Dollars per ton July-June	Cottonseed Dollars per ton July-June	Truck Crops ....
Av. Aug. 1909–July 1914	12.4	10.0	69.7	87.8	64.2	88.4	11.87	22.55	....
1930	9.5	12.8	91.2	108.1	59.8	67.1	11.06	22.04	....
1931	5.7	8.2	46.0	72.6	32.0	39.0	8.69	8.97	....
1932	6.5	10.5	38.0	54.2	31.9	28.2	6.20	10.33	....
1933	10.2	13.0	82.4	69.4	52.2	74.4	8.09	12.88	....
1934	12.4	21.3	44.6	79.8	81.5	84.8	13.20	33.00	....
1935	11.1	18.4	59.3	70.3	65.5	83.2	7.52	30.54	....
1936	12.4	23.6	114.2	92.9	104.4	102.5	11.20	33.36	....
1937	8.4	20.4	52.9	78.0	51.8	96.2	8.74	19.51	....
1938	8.6	19.6	55.7	69.8	48.6	56.2	6.78	21.79	....
1939	9.1	15.4	69.7	73.4	56.8	69.1	7.94	21.17	....
1940	9.9	16.0	54.1	85.4	61.8	68.2	7.59	21.73	....
1941	17.0	26.4	80.8	92.2	75.1	94.4	9.70	47.65	....
1942	19.0	36.9	117.0	118.0	91.7	110.0	10.80	45.61	....
1943	19.9	40.5	131.0	206.0	112.0	136.0	14.80	52.10	....
1944	20.7	42.0	150.0	190.0	109.0	141.0	16.50	52.70	....
1945	22.5	36.6	143.0	204.0	127.0	150.0	15.10	51.10	....
1946	32.6	38.2	124.0	218.0	156.0	191.0	16.70	72.00	....
1947	31.9	38.0	162.0	217.0	216.0	229.0	17.60	85.90	....
1948	30.4	48.2	155.0	222.0	129.0	200.0	18.45	67.20	....
1949	28.6	45.9	128.0	214.0	124.0	188.0	16.50	43.40	....
1950	40.1	51.7	91.7	173.0	153.0	200.0	16.70	86.50	....
1951	37.9	51.1	163.0	304.0	166.0	211.0	19.50	69.30	....
1952	34.6	49.9	198.0	338.0	153.0	209.0	19.95	69.60	....
1953	32.3	52.2	78.1	244.0	148.0	204.0	17.45	52.60	....
1954	33.6	51.1	130.0	229.0	142.0	212.0	17.35	60.30	....
1955	32.3	53.1	94.2	177.0	131.0	198.0	17.65	44.60	....
1956									
February	31.00	35.4	114.0	198.0	118.0	195.0	16.45	46.20	....
March	31.64	....	134.0	209.0	120.0	197.0	16.15	46.80	....
April	32.50	....	172.0	217.0	132.0	203.0	16.25	46.90	....
May	31.96	54.0	219.0	231.0	139.0	200.0	16.15	47.30	....
June	32.29	51.0	265.2	290.5	142.0	193.0	15.05	47.40	....
July	32.36	48.0	311.4	348.7	143.0	190.0	14.85	49.00	....
August	31.13	50.1	140.0	217.8	145.0	193.0	15.25	51.00	....
September	32.50	53.4	100.0	191.0	143.0	195.0	15.95	47.60	....
October	31.94	53.0	80.4	194.0	119.0	198.0	16.75	54.10	....
November	31.88	47.9	91.8	203.5	121.0	205.0	17.15	59.20	....
December	30.99	61.0	91.2	241.0	122.0	207.0	17.95	59.90	....
1957									
January	30.21	52.7	93.6	257.0	123.0	209.0	18.15	60.40	....
Index Numbers (Aug. 1909—July 1914 = 100)									
1930	77	128	131	123	93	76	93	98	128
1931	46	82	66	83	50	44	73	40	107
1932	52	105	55	62	50	43	52	46	100
1933	82	130	118	79	81	84	68	57	90
1934	100	213	64	91	127	96	111	146	94
1935	90	184	85	80	102	94	63	135	116
1936	100	236	164	106	163	116	94	148	108
1937	68	204	76	89	81	109	74	87	114
1938	69	196	80	79	76	64	57	97	96
1939	73	154	100	84	88	78	67	94	98
1940	80	160	78	97	96	77	64	96	122
1941	137	264	116	105	117	107	82	211	138
1942	153	369	168	134	143	124	91	202	178
1943	160	405	188	235	174	154	125	231	270
1944	167	420	214	216	170	160	139	234	236
1945	181	366	205	232	198	170	127	227	240
1946	263	382	178	248	212	209	141	319	217
1947	257	380	232	248	336	259	148	381	262
1948	245	482	222	253	201	226	155	298	253
1949	231	459	184	244	193	213	139	192	232
1950	323	517	132	197	238	226	141	384	211
1951	306	512	233	346	259	239	164	307	269
1952	279	499	284	385	238	236	168	309	274
1953	260	522	112	278	231	231	147	233	239
1954	270	511	187	261	221	240	146	267	223
1955	260	531	135	202	204	224	149	198	233
1956									
February	250	354	164	226	184	221	139	205	244
March	255	...	192	238	187	223	136	208	214
April	262	...	247	247	206	230	137	208	202
May	258	540	314	263	217	226	136	210	239
June	260	510	389	331	221	218	127	210	345
July	261	480	455	397	223	215	125	217	351
August	251	501	201	248	226	218	128	226	230
September	262	534	143	218	223	221	134	211	243
October	258	530	115	221	185	224	141	240	252
November	257	479	132	232	188	232	145	263	274
December	250	610	131	274	190	234	151	266	266
1957									
January	244	527	134	293	192	236	153	268	220

Wholesale Prices of Phosphates and Potash * *

	Superphosphate, Baltimore, per unit	Florida land, pebble, 68% f.o.b. mines, bulk, per ton	Tennessee phosphate rock, 75% f.o.b. mines, bulk, per ton	Muriate of potash bulk, per unit, c.i.f. Atlantic and Gulf ports [2]	Sulphate of potash in bags, per unit, c.i.f. Atlantic and Gulf ports [2]	Sulphate of potash magnesia, per ton, c.i.f. Atlantic and Gulf ports [2]	Manure salts bulk, per unit, c.i.f. Atlantic and Gulf ports [2]
1910–14	$0.536	$3.61	$4.88	$0.714	$0.953	$24.18	$0.657
1930	.542	3.18	5.50	.681	.973	26.92	.618
1931	.485	3.18	5.50	.681	.973	26.92	.618
1932	.458	3.18	5.50	.681	.963	26.90	.618
1933	.434	3.11	5.50	.662	.864	25.10	.601
1934	.487	3.14	5.67	.486	.751	22.49	.483
1935	.492	3.30	5.69	.415	.684	21.44	.444
1936	.476	1.85	5.50	.464	.708	22.94	.505
1937	.510	1.85	5.50	.508	.757	24.70	.556
1938	.492	1.85	5.50	.523	.774	15.17	.572
1939	.478	1.90	5.50	.521	.751	24.52	.570
1940	.516	1.90	5.50	.517	.730	24.75	.573
1941	.547	1.94	5.64	.522	.780	25.55	.367
1942	.600	2.13	6.29	.522	.810	25.74	.205
1943	.631	2.00	5.93	.522	.786	25.35	.195
1944	.645	2.10	6.10	.522	.777	25.35	.195
1945	.650	2.20	6.23	.522	.777	25.35	.195
1946	.671	2.41	6.50	.508	.769	24.70	.190
1947	.746	3.05	6.60	.432	.706	18.93	.195
1948	.764	4.27	6.60	.397	.681	14.14	.195
1949	.770	3.88	6.22	.397	.703	14.14	.195
1950	.763	3.83	5.47	.371	.716	14.33	.195
1951	.813	3.98	5.47	.401	.780	15.25	.200
1952	.849	3.98	5.47	.401	.793	15.25	.200
1953	.878	....	....	.410	.793	15.25	.200
1954	.895	....	....	.405	.791	15.27	.200
1955	.895	....	....	.394	.771	14.79	.177
1956							
February	.895	....	....	.380	.735	14.00	.193
March	.895	....	....	.380	.735	14.00	.193
April	.895	....	....	.380	.735	14.00	.193
May	.895	....	....	.380	.735	14.00	.193
June	.895	....	....	.360	.720	13.45	.177
July	.895	....	....	.380	.735	14.00	.177
August	.895	....	....	.380	.735	14.00	.177
September	.895	....	....	.380	.735	14.00	.177
October	.895	....	....	.380	.735	14.00	.177
November	.895	....	....	.380	.735	14.00	.177
December	.895	....	....	.380	.735	14.00	.177
1957							
January	.895	....	....	.380	.735	14.00	.177
	Index Numbers (1910-14 = 100)						
1930	101	88	113	95	102	111	94
1931	90	88	113	95	102	111	94
1932	85	88	113	95	101	111	94
1933	81	86	113	93	91	104	91
1934	91	87	110	68	79	93	74
1935	92	91	117	58	72	89	68
1936	89	51	113	65	74	95	77
1937	95	51	113	71	79	102	85
1938	92	51	113	73	81	104	87
1939	89	53	113	73	79	101	87
1940	96	53	113	72	77	102	87
1941	102	54	110	73	82	106	87
1942	112	59	129	73	85	106	84
1943	117	55	121	73	82	105	83
1944	120	58	125	73	82	105	83
1945	121	61	128	73	82	105	83
1946	125	67	133	71	81	102	82
1947	139	84	135	70	74	78	83
1948	143	118	135	67	72	58	83
1949	144	108	128	67	74	58	83
1950	142	106	112	68	75	59	83
1951	152	110	112	72	82	63	83
1952	158	110	112	72	83	63	83
1953	164	...	...	73	83	63	83
1954	167	...	...	72	83	63	83
1955	167	...	...	70	81	61	82
1956							
February	167	...	...	69	77	58	82
March	167	...	...	69	77	58	82
April	167	...	...	69	77	58	82
May	167	...	...	69	77	58	82
June	167	...	...	66	76	56	80
July	167	...	...	69	77	58	80
August	167	...	...	69	77	58	80
September	167	...	...	69	77	58	80
October	167	...	...	69	77	58	80
November	167	...	...	69	77	58	80
December	167	...	...	69	77	58	80
1957							
January	167	...	...	69	77	58	80

Wholesale Prices of Ammoniates * *

	Nitrate of soda bulk per unit N	Sulphate of ammonia bulk per unit N	Cottonseed meal S. E. Mills per unit N	Fish, scrap, dried 11–12% ammonia, 15% bone phosphate, f.o.b. factory bulk per unit N	Tankage 11% ammonia, 15% bone phosphate, f.o.b. Chicago, bulk, per unit N	High grade ground blood, 16–17% ammonia, Chicago, bulk, per unit N
1910–14	$2.68	$2.85	$3.50	$3.53	$3.37	$3.52
1930	2.47	1.81	4.78	4.96	3.79	4.58
1931	2.34	1.46	3.10	3.95	2.11	2.46
1932	1.87	1.04	2.18	2.18	1.21	1.36
1933	1.52	1.12	2.95	2.86	2.06	2.46
1934	1.52	1.20	4.46	3.15	2.67	3.27
1935	1.47	1.15	4.59	3.10	3.06	3.65
1936	1.53	1.23	4.17	3.42	3.58	4.25
1937	1.63	1.32	4.91	4.66	4.04	4.80
1938	1.69	1.38	3.69	3.76	3.15	3.53
1939	1.69	1.35	4.02	4.41	3.87	3.90
1940	1.69	1.36	4.64	4.36	3.33	3.39
1941	1.69	1.41	5.50	5.32	3.76	4.43
1942	1.74	1.41	6.11	5.77	5.04	6.76
1943	1.75	1.42	6.30	5.77	4.86	6.62
1944	1.75	1.42	7.68	5.77	4.86	6.71
1945	1.75	1.42	7.81	5.77	4.86	6.71
1946	1.97	1.44	11.04	7.38	6.60	9.33
1947	2.50	1.60	12.72	10.66	12.63	10.46
1948	2.86	2.03	12.94	10.59	10.84	9.85
1949	3.15	2.29	10.11	13.18	10.73	10.62
1950	3.00	1.95	11.01	11.70	10.21	9.36
1951	3.16	1.97	13.20	10.92	10.18	10.09
1952	3.34	2.09	13.95	11.27	9.72	9.16
1953	3.26	2.27	11.04	11.19	7.39	7.09
1954	3.07	2.20	11.50	11.63	9.72	9.85
1955	2.98	2.11	9.97	12.01	6.96	6.91
1956						
February	2.98	2.12	8.69	12.15	5.77	5.69
March	2.98	2.12	8.30	11.89	5.92	5.92
April	2.98	2.12	8.31	11.66	5.77	5.71
May	2.98	1.70	8.67	11.80	6.60	6.37
June	2.98	1.56	8.72	11.29	6.37	6.23
July	2.98	1.56	9.37	10.89	6.80	6.37
August	2.98	1.56	9.99	11.26	6.53	6.37
September	2.98	1.56	9.10	11.28	6.68	6.68
October	2.90	1.56	9.11	11.35	7.53	6.86
November	2.88	1.56	9.41	11.58	6.07	6.37
December	2.88	1.56	9.47	11.80	6.61	6.07
1957						
January	2.88	1.56	9.60	11.80	6.98	6.68
Index Numbers (1910-14 = 100)						
1930	92	64	137	141	112	130
1931	88	51	89	112	63	70
1932	71	36	62	62	36	39
1933	59	39	84	81	97	71
1934	59	42	127	89	79	93
1935	57	40	131	88	91	104
1936	59	43	119	97	106	131
1937	61	46	140	132	120	122
1938	63	48	105	106	93	100
1939	63	47	115	125	115	111
1940	63	48	133	124	99	96
1941	63	49	157	151	112	126
1942	65	49	175	163	150	192
1943	65	50	180	163	144	189
1944	65	50	219	163	144	191
1945	65	50	223	163	144	191
1946	74	51	315	209	196	265
1947	93	56	363	302	374	297
1948	107	71	370	300	322	280
1949	117	80	289	373	318	302
1950	112	68	315	331	303	266
1951	118	69	377	310	302	287
1952	125	74	399	319	288	260
1953	122	80	315	317	219	201
1954	114	77	329	330	288	280
1955	111	74	285	340	207	196
1956						
February	111	74	248	344	171	162
March	111	74	237	337	176	168
April	111	74	237	330	171	162
May	111	60	248	334	196	181
June	111	55	249	320	189	177
July	111	55	268	308	202	181
August	111	55	285	319	194	181
September	111	55	260	320	198	190
October	108	55	260	322	223	195
November	107	55	269	328	180	181
December	107	55	271	334	196	172
1957						
January	107	55	274	334	207	190

Combined Index Numbers of Prices of Fertilizer Materials, Farm Products and All Commodities

	Farm prices*	Prices paid by farmers for commodities bought*	Wholesale prices of all commodities†	Fertilizer material‡	Chemical ammoniates	Organic ammoniates	Superphosphate	Potash**
1930.....	125	140	126	105	72	131	101	99
1931.....	87	119	107	83	62	83	90	99
1932.....	65	102	95	71	46	48	85	99
1933.....	70	104	96	70	45	71	81	95
1934.....	90	118	109	72	47	90	91	72
1935.....	109	123	117	70	45	97	92	63
1936.....	114	123	118	73	47	107	89	69
1937.....	122	130	126	81	50	129	95	75
1938.....	97	122	115	78	52	101	92	77
1939.....	95	121	112	79	51	119	89	77
1940.....	100	122	115	80	52	114	96	77
1941.....	124	130	127	86	56	130	120	77
1942.....	159	149	144	93	57	161	112	77
1943.....	193	165	151	94	57	160	117	77
1944.....	197	174	152	96	57	174	120	76
1945.....	207	180	154	97	57	175	121	76
1946.....	236	197	177	107	62	240	125	75
1947.....	276	231	222	130	74	362	139	72
1948.....	287	250	241	134	89	314	143	70
1949.....	250	240	226	137	99	319	144	70
1950.....	258	246	232	132	89	314	142	72
1951.....	302	271	258	139	93	331	152	76
1952.....	288	273	251	144	98	333	158	76
1953.....	258	262	247	139	100	269	164	77
1954.....	249	263	248	142	95	311	167	76
1955.....	237	262	249	134	92	255	167	74
1956								
February..	226	259	252	130	92	225	167	72
March....	228	261	254	130	92	222	167	72
April.....	235	261	257	130	92	219	167	72
May.....	242	264	257	128	85	236	167	72
June.....	247	264	257	126	82	231	167	70
July.....	244	266	257	128	82	242	167	72
August....	237	267	259	128	82	246	167	72
September.	236	266	259	128	82	239	167	72
October...	234	265	259	128	81	252	167	72
November.	234	267	261	126	80	234	167	72
December..	237	268	261	127	80	244	167	72
1957								
January...	238	269	263	128	80	251	167	72

* U. S. D. A. figures, revised January 1950. Beginning January 1946 farm prices and index numbers of specific farm products revised from a calendar year to a crop-year basis. Truck crops index adjusted to the 1924 level of the all-commodity index.

† Department of Labor index converted to 1910-14 base.

‡ The Index numbers of prices of fertilizer materials are based on original study made by the Department of Agricultural Economics and Farm Management, Cornell University, Ithaca, New York. These indexes are complete since 1897. The series was revised and reweighted as of March 1940 and November 1942.

[1] **Beginning July 1949, baled hay prices reduced by $4.75 a ton to be comparable to loose hay prices previously quoted.**

[2] **Potash salts quoted F.O.B. mines; manure salts since June 1941; other carriers since June 1947.**

** **Where range of prices for fertilizer material is quoted, average figure is used. The weighted average of prices actually paid for potash is lower than the annual average because since 1926 over 90% of the potash used in agriculture has been contracted for during the discount period.**

REVIEWS

This section contains a short review of some of the most practical and important bulletins, and lists all recent publications of the United States Department of Agriculture, the State Experiment Stations, and Canada, relating to Fertilizers, Soil, Crops, and Economics. A file of this department of BETTER CROPS WITH PLANT FOOD would provide a complete index covering all publications from these sources on the particular subjects named.

Fertilizers

"Fertilizers, Fertilizer Materials, and Rock Phosphate Sold in Illinois, January 1, 1956 to June 30, 1956," Agr. Exp. Sta., Univ. of Ill., Urbana, Ill., AG1729, Oct. 1956, L. T. Kurtz and N. G. Pieper.

"Nitrogen for Illinois Corn," Agr. Exp. Sta., Univ. of Ill., Urbana, Ill., AG1481, Rev. 1956, L. B. Miller.

"Research in Progress on the Agronomy South Farm, Winter Application of Nitrogen Fertilizers," Agr. Exp. Sta., Univ. of Ill., Urbana, Ill., AG 1712, June 1956.

"Nitrogen Sidedressing on Corn, Demonstration Results 1952-54," Agr. Ext. Serv., Univ. of Minn., St. Paul, Minn., Soil Series 42, Dec. 1955, H. E. Jones and C. A Simkins

"Studies on Phosphate Fertilizers in Minnesota," Agr. Exp. Sta., Univ. of Minn., St. Paul, Minn., Soil Series 44, A. C. Caldwell.

"The Truth About pH," Agr. Ext. Serv., Miss. State College, State College, Miss., Pub. 324, June 1956, L. E. Gholston and J. D. Lancaster.

"1956 Commercial Fertilizer Results with Spring Small Grains," Agr. Exp. Sta., Univ. of Nebr., Lincoln, Nebr., Outstate Testing Cir. 56, Sept. 1956, G. W. Lowrey, R. A. Olson, and P. L. Ehlers

"Forms of Nitrogen Fertilizer," Agr. Ext. Serv., N. Dak. Agr. College, Fargo, N. Dak., Cir. A-242, Sept. 1955, V. L. Weiser.

"Liquid Fertilizers, Their Use in Foliage Sprays and Seed Applications," Agr. Ext. Serv., N. Dak. Agr. College, Fargo, N. Dak., Cir. A-252, April 1956, V. L. Weiser.

Soils

"Henderson County Soils," Agr. Exp. Sta., Univ. of Ill., Urbana, Ill., Soil Rpt. 77, Jan. 1956, P. T. Veale and H. L. Wascher.

"Managing Soil Bank Acres," Agr. Ext. Serv., Univ. of Ill., Urbana, Ill., Cir. 766, Dec. 1956, E. C. Spurrier.

"Minnesota Soil Test Summaries," Agr. Exp. Sta., Univ. of Minn., St. Paul, Minn., Soil Series 45, J. Grava.

"Chemical Treatments for the Control of Weeds and Diseases in Tobacco Plant Beds," Agr. Exp. Sta., N. C. State College, Raleigh, N. C., Tech. Bul. 119, March 1956, F. A. Todd and E. E. Clayton.

"Production of Lettuce Seed as Affected by Soil Moisture and Fertility," Agr. Exp. Sta., Utah State Agr. College, Logan, Utah, Bul. 386, June 1956, L. R. Hawthorn and L. H. Pollard.

"Saline and Alkali Soils, What To Do About Them," Agr. Ext. Serv., Utah State Agr. College, Logan, Utah, Lflt. 5, Jan. 1956, P. D. Christensen.

"Soil Tests Can Help You," Agr. Ext. Serv., Utah State Agr. College, Logan, Utah, Lflt. 3, Jan. 1956, P. D. Christensen.

Crops

"Crested Wheat Grass," Dept. of Agr., Ottawa, Ont., Can., Pub. 986, Oct. 1956, R. P. Knowles.

"Report of the Minister of Agriculture for the Year Ending March 31, 1956," Dept. of Agr., Ottawa, Ont., Can.

"Colorado Turfgrasses, Basic Facts About Grasses and a Key for Identification," Agr. Ext. Serv., Colo. A. & M. College, Fort Collins, Colo., Cir. 2663, Sept. 1956, J. L. Fults.

"Pilot, a New Hybrid Onion for Western Colorado," Agr. Exp. Sta., Colo. A. & M. College, Fort Collins, Colo., Pamph. 2-S, Nov. 1956, A. C. Ferguson and H. A. Jones.

"Home Garden for the Coastal Plain of Georgia," Ga. Coastal Plain Exp. Sta., Tifton, Ga., Mimeo. Paper 12, Rev. Dec. 1956, O. Woodard.

"Lawns," Agr. Ext. Serv., Univ. of Ga., Athens, Ga., Cir. 380, Rev. Oct. 1956, T. G. Williams.

"Varieties of Fruits Adapted for Home Use in the Coastal Plain of Georgia," Ga. Coastal Plain Exp. Sta., Tifton, Ga., Mimeo. Paper 29, Rev. Nov. 1956.

"Carnation Variety Trial," Agr. Exp. Sta., Univ. of Hawaii, Honolulu, Hawaii, Cir. 51, July 1956, H. Kamemoto and H. Y. Nakasone.

"Pangola and Colonial Guinea Grass Management, Additional Notes," Agr. Ext. Serv., Univ. of Hawaii, Honolulu, Hawaii, Ext. Cir. 353, May 1956, E. Y. Hosaka.

"The Place of Grain Sorghums in Illinois," Agr. Exp. Sta., Univ. of Ill., Urbana, Ill., AG1692, March 1956, C. N. Hittle, R. O. Weibel, J. W. Pendleton, and G. E. McKibben.

"Research in Progress on the Agronomy South Farm, Effects of Planting Rate and Light Intensity on Corn Yields," Agr. Exp.

Sta., Univ. of Ill., Urbana, Ill., AG1707, June 1956.

"Research in Progress on the Agronomy South Farm, Establishing Legumes in Corn," Agr. Exp. Sta., Univ. of Ill., Urbana, Ill., AG1709, June 1956.

"Research in Progress on the Agronomy South Farm, Effects of Frequency and Dates of Cutting on Dry-Matter Yields of Four Sudangrass Varieties," Agr. Exp. Sta., Univ. of Ill., Urbana, Ill., AG1713, July 1956.

Economics

"Profitability of Alternative Forage Programs on Delaware Dairy Farms," Agr. Exp. Sta., Univ. of Del., Newark, Del., A. E. Pamph. 14, Dec. 1956, W. E. McDaniel and W. H. West.

"Some Items of Interest to Kentucky Nurserymen for the Year Ended June 30, 1955," Agr. Exp. Sta., Univ. of Ky., Lexington, Ky., Reg. Bul. 126, Dec. 1955, W. A. Price and H. G. Tilson.

"Costs and Returns in Sweet Corn Production-Central Maine, 1955," Agr. Exp. Sta., Univ. of Maine, Orono, Maine, Bul. 550, Aug. 1956, W. E. Schrumpf and W. E. Pullen.

"How to Increase Your Farm Profits," Agr. Exp. Sta., Univ. of Mo., Columbia, Mo., Bul. 675, Oct. 1956, G. B. Nance.

"Economic Survey of Resources Used by Dairy Farmers in Oklahoma," Agr. Exp. Sta., Okla. A. & M. College, Stillwater, Okla., Bul. B-482, Dec. 1956, F. L. Underwood.

"Report of the Oklahoma Agricultural Experiment Station as of June 30, 1956, and Showing Changes During the Biennium July 1, 1954, to June 30, 1956," Agr. Exp. Sta., Okla. A. & M. College, Stillwater, Okla.

"Grain Marketing Facilities and Practices in South Carolina," USDA, Wash., D. C., Mktg. Res. Rpt. 138, Oct. 1956, T. D. Johnson, W. E. Blackmore, E. W. Siedschlag, and P. S. Richey.

"American Farming, an Introduction for Young People," USDA, Wash., D. C., Misc. Pub. 720, Nov. 1956.

"Agricultural Marketing Research, Its Use, Appraisal, and Prospect, a Report of the National Workshop on Agricultural Marketing, July 13-20, 1956, Iowa State College," USDA, Wash., D. C., AMS-60.

"Costs and Returns, Commercial Family-Operated Farms, by Type and Size, 1930-1951," USDA, Wash., D. C., Stat. Bul. 197, Nov. 1956, W. D. Goodsell.

"Food Transportation and What It Costs Us," USDA, Wash., D. C., Misc. Pub. 738, Nov. 1956.

"Foreign Agricultural Trade, Statistical Handbook," USDA, Wash., D. C., Stat. Bul. 179, Aug. 1956.

"U. S. Agricultural Exports in Historical Perspective," USDA, Wash., D. C., FAS-Neg. 746, Rev. Nov. 1956.

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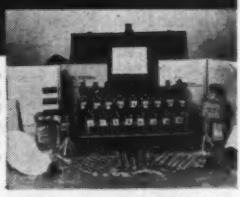

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It was one of those mountain roads and the tourist stopped to ask directions from a native.

"Pardon me, sir," said the stranger, "can you tell me where this road goes?"

"Well," said the hillbilly, "this road just moseys along a piece, then it turns into a hog trail, then a squirrel track, and finally runs up a scrub pine and ends in a knothole."

* * *

A young man was seated opposite a nice old lady in a Pullman car. For some time he sat vigorously chewing gum.

Finally the old lady leaned forward and said: "It's so nice of you to try to make conversation, but I must tell you I am stone deaf."

* * *

Engaged sister to her fiance: "When we are married, dear, we must have a hyphenated name. It's much smarter. What would go well with Eaton?"

Her small brother from behind the sofa: "Moth."

* * *

Jim: "What's a chaperone?"

Joe: "That's an old maid who never made the first team but still hopes to intercept a few passes."

An old maid was aroused one night to find a man under her bed. She neither fainted nor screamed. Instead she said:

"Sit down, sir. I want to talk with you."

An hour later there came a frantic ring over the phone at police headquarters.

Voice—There's a burglar in Miss Spinster's bedroom. Send the police at once.

Sergeant—All right. Is this Miss Spinster speaking?

Voice—No, this is the burglar.

* * *

The visitor leaned on the fence watching the old farmer plow. "I don't like to tell you how to run your business," he finally said, "but you could save yourself a lot of work by saying 'gee' and 'haw' to that mule instead of just pulling the lines."

The farmer mopped his brow and said, "I reckon you're right but this mule kicked me five years ago and I haven't spoke to him since."

* * *

They're picking up the pieces
With a dustpan and a rake,
Because he grabbed a silken knee
When he should have grabbed the brake.

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